Geology and Geochemistry of Selected Granitoid Plutons of Cape Breton Island

by S.M. Barr, G.A. O'Reilly and A.M. O'Beirne

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TABLE OF CONTENTS

		Page
	ABSTRACT	1
	ACKNOWLEDGMENTS	2
CHAPTER 1.	INTRODUCTION	3
	Purpose of the Study	3
	Selection of Plutons for Study	3
	Field Methods	3
	Laboratory Methods	3
	Presentation of Data	4
CHAPTER 2.	HUNTINGTON MOUNTAIN PLUTON	7
	Introduction	7
	Location and Access	7
	Size and Exposure	7
	Previous Work	7
	Geological Setting	7
	Plutonic Rocks	7
	Field Relations	7
	Petrography	9
	Dioritic Complex	9
	Porphyritic Quartz Monzonite	9
	Biotite Granite and Leucogranite	9
	Geochemistry	9
	Major Element Geochemistry	9
	Trace Element Geochemistry	10
	Economic Geology	11
	Age	11
	Summary	11
CHAPTER 3.	KELLYS MOUNTAIN PLUTON	15
	Introduction	15
	Location and Access	15
	Size and Exposure	15
	Previous Work	15
	Geological Setting	15
	Country Rocks	15
	Gneissic Complex	15
	George River Group	15
	Carboniferous Sedimentary Rocks	17
	Dykes	17
	Plutonic Rocks	17
	Field Relations	17
	Petrography	18
	Dioritic Complex	18
	Leucogranite	18
	Geochemistry	18
	Major Element Geochemistry	18
	Trace Element Geochemistry	19
	Economic Geology	23
	Age	23
	Summary	23
CHAPTER 4.	ST. ANNS MOUNTAIN PLUTON	25
	Introduction	25
	Location and Access	25
	Size and Exposure	25
	Previous Work	25
	Geological Setting	25
	Plutonic Rocks	25
	Field Relations	25
	Petrography	28
	Hornblende Granodiorite and Related Phases	28
	Hornblende Biotite Granite and Granodiorite	28
	Leucogranite and Related phases	28
	Quartz Diorite and Granodiorite	29
	Porphyritic Quartz Monzonite	29
	Geochemistry	29
	Major Element Geochemistry	29
	Trace Element Geochemistry	29
	Economic Geology	30
	Age	30
	Summary	30

		Page
CHAPTER 5.	CAPE SMOKY PLUTON	35
	Introduction	35
	Location and Access	35
	Size and Exposure	35
	Previous Work	35
	Geological Setting	35
	Plutonic Rocks	35
	Field Relations	35
	Petrography	37
	Quartz Diorite and Related Phases	37
	Granodiorite	37
	Biotite Granite	37
	Aplite, Pegmatite and Porphyritic Microgranite	37
	Geochemistry	37
	Major Element Geochemistry	37
	Trace Element Geochemistry	38
	Economic Geology	39
	Age	39
	Summary	39
CHAPTER 6.	WHITE POINT PLUTON	43
	Introduction	43
	Location and Access	43
	Size and Exposure	43
	Previous Work	43
	Geological Setting	43
	Plutonic Rocks	45
	Field Relations	45
	Petrography	45
	Granodiorite	45
	Granite	45
	Pegmatite	45
	Aplite	45
	Geochemistry	46
	Major Element Geochemistry	46
	Trace Element Geochemistry	46
	Economic Geology	47
	Age	47
	Summary	47
CHAPTER 7.	GILLIS MOUNTAIN PLUTON	51
	Introduction	51
	Location and Access	51
	Previous Work	52
	Geological Setting	52
	Country Rocks	52
	Contact Relations	52
	Contact Metamorphism	52
	Plutonic Rocks	52
	Field Relations	52
	Petrography	53
	Quartz Monzodiorite	53
	Porphyritic Granite	53
	Fine Grained Granite	53
	Minor Phases	54
	Geochemistry	54
	Major Element Geochemistry	54
	Trace Element Geochemistry	55
	Economic Geology	59
	Age	59
	Summary	59
CHAPTER 8.	DEEP COVE PLUTON	61
	Introduction	61
	Location and Access	61
	Size and Exposure	61
	Previous Work	61
	Geological Setting	61
	Plutonic Rocks	61
	Field Relations	61
	Petrography	61
	Geochemistry	62
	Major Element Geochemistry	62
	Trace Element Geochemistry	62

		Page
	Economic Geology	62
	Age	66
	Summary	66
CHAPTER 9.	PETIT-DE-GRAT PLUTON	67
	Introduction	67
	Location and Access	67
	Size and Exposure	67
	Previous Work	67
	Geological Setting	67
	Plutonic Rocks	67
	Field Relations	67
	Petrography	67
	Geochemistry	67
	Major Element Geochemistry	67
	Trace Element Geochemistry	67
	Economic Geology	68
	Age	68
	Summary	68
CHAPTER 10.	ADDITIONAL TRACE ELEMENT GEOCHEMISTRY	73
	Introduction	73
	Discussion of the Data	73
	Antimony	73
	Boron	73
	Beryllium	73
	Bismuth	73
	Cadmium	73
	Cobalt	73
	Lithium	73
	Nickel	73
	Niobium	73
	Yitrium	76
	Zirconium	76
	Conclusions	76
CHAPTER 11.	SYNTHESIS	77
	Age and Field Relations	77
	Petrography	77
	Major Element Geochemistry	78
	Trace Element Geochemistry	78
	Arsenic	78
	Barium	78
	Copper	81
	Fluorine	81
	Lead	81
	Molybdenum	81
	Rubidium	81
	Strontium	81
	Sulphur	96
	Tin	96
	Uranium	96
	Zinc	96
	Background and Anomalous Populations	96
	Conclusions	97
CHAPTER 12.	ECONOMIC IMPLICATIONS	103
	Introduction	103
	S-Type and I-Type Characteristics	103
	Comparison with "Specialized"Granites	103
	Major Element Geochemistry	103
	Trace Element Geochemistry	103
	Element Ratios	103
	Economic Potential	105
REFERENCES		107
APPENDIX A.	Method of Staining Rock Slabs	111
APPENDIX B.	Methods of Analyses	113
	Sample Preparation	113
	Analytical Techniques	113
	Accuracy	113
	Precision	113
APPENDIX C.	Petrographic Descriptions of Analyzed Samples	119
APPENDIX D.	Compilation of Major and Trace Element Analyses and CIPW Normative Mineralogies	137

Page

APPENDIX E. Compilation of Sb, B, Be, Bi, Cd, Co, Li, Ni, Nb, Y, and Zr Data 171

LIST OF FIGURES

Figure 1-1. Distribution of granitoid rocks in Cape Breton Island and location of plutons described in this report. 3

Figure 1-2. Nomenclature for granitoid rocks used in this report (after Streckeisen, 1976). Q = quartz; A = alkali feldspar; P = plagioclase. 4

Figure 2-1. Geology of the Huntington Mountain pluton. 8

Figure 2-2. Modal mineralogy (a) and normative mineralogy (b) for Huntington Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; An + Ab = normative anorthite plus albite. 10

Figure 2-3. Silica variation diagrams for major element oxides in the Huntington Mountain pluton. Symbols as in Figure 2-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 12

Figure 2-4. Silica variation diagrams for trace elements in the Huntington Mountain pluton. Symbols and lines as in Figures 2-2 and 2-3, respectively. ... 13

Figure 3-1. Geology of the Kellys Mountain pluton. 16

Figure 3-2. Modal mineralogy (a) and normative mineralogy (b) for Kellys Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite. 18

Figure 3-3. Silica variation diagrams for major element oxides in the Kellys Mountain pluton. Symbols as in Figure 3-2 except fine grained granite is grouped with leucogranite. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 20

Figure 3-4. Silica variation diagrams for trace elements in the Kellys Mountain pluton. Symbols and lines as in Figures 3-2 and 3-3, respectively. .. 21

Figure 4-1. Geology of the St. Anns Mountain pluton. See Figure 1-1 for location of map area. 26

Figure 4-2. Modal mineralogy (a) and normative mineralogy (b) for St. Anns Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN +AB = normative anorthite plus albite. 28

Figure 4-3. Silica variation diagrams for major element oxides in the St. Anns Mountain pluton. Symbols as in Figure 4-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 31

Figure 4-4. Silica variation diagrams for trace elements in the St. Anns Mountain pluton. Symbols and lines as in Figures 4-2 and 4-3, respectively. .. 32

Figure 5-1. Geology of the Cape Smoky pluton. See Figure 1-1 for location of map area. 36

Figure 5-2. Modal mineralogy (a) and normative mineralogy (b) for Cape Smoky pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite. 38

Figure 5-3. Silica variation diagrams for major element oxides in the Cape Smoky pluton. Symbols as in Figure 5-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 40

Page

Figure 5-4. Silica variation diagrams for trace elements in the Cape Smoky pluton. Symbols and lines as in Figures 5-2 and 5-3, respectively. 41

Figure 6-1. Geology of the White Point pluton. See Figure 1-1 for location of map area. 44

Figure 6-2. Modal mineralogy (a) and normative mineralogy (b) for White Point pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite. 46

Figure 6-3. Silica variation diagrams for major element oxides in the White Point pluton. Symbols as in Figure 6-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 48

Figure 6-4. Silica variation diagrams for trace elements in the White Point pluton. Symbols and lines as in Figures 6-2 and 6-3 respectively. 49

Figure 7-1. Geology of the Gillis Mountain pluton. 51

Figure 7-2. Modal mineralogy (a) and normative mineralogy (b) for Gillis Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite. 54

Figure 7-3. Silica variation diagrams for major element oxides in the Gillis Mountain pluton. Symbols as in Figure 7-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 56

Figure 7-4. Silica variation diagrams for trace elements in the Gillis Mountain pluton. Symbols and lines as in Figures 7-2 and 7-3, respectively. .. 57

Figure 7-5. Selected trace element concentrations in samples from the Gillis Mountain pluton. Pluton outline and sample locations as in Figure 7-1. Dd = quartz monzodiorite; Dpg = porphyritic granite; Dg = fine grained granite. 60

Figure 8-1. Location of sampling sites for analyzed rocks in or near the Deep Cove pluton. Samples from outside the pluton boundary are from granitic dykes. 61

Figure 8-2. Modal mineralogy (a) and normative mineralogy (b) for Deep Cove pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR normative orthoclase; AN + AB = normative anorthite plus albite. 62

Figure 8-3. Silica variation diagrams for major element oxides in the Deep Cove pluton. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 63

Figure 8-4. Silica variation diagrams for trace elements in the Deep Cove pluton. Lines as in Figure 8-3. 64

Figure 9-1. Geology of the Petit-de Grat pluton. 67

Figure 9-2. Modal mineralogy (a) and normative mineralogy (b) for Petit-de-Grat pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus ablite. 68

Figure 9-3. Silica variation diagrams for major element oxides in the Petit-de-Grat pluton. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 70

Figure 9-4. Silica variation diagrams for trace elements in the Petit-de-Grat pluton. Lines as in Figure 9-3. 71

Page

Figure 10-1. Silica variation diagrams for B, Be, Bi, Co, Li, Ni, Y, and Zr. Symbols as shown. Lines are average trends for calc-alkalic plutonic rocks from Gribble (1969). 74

Figure 11-1. Summary silica variation diagrams for major element oxides in the plutons of this study. Each numbered field encompasses all data points for the pluton. Deep Cove - Gillis Mountain pluton fields are dotted for emphasis. 79

Figure 11-2. Compilation of means and standard deviations for major element oxides in the "granitic" phases of the plutons (those containing more than 65% SiO_2). 81

Figure 11-3. Summary silica variation diagrams for trace elements in the plutons of this study. Mean $\pm$ standard deviation are shown for each phase of each pluton. Data are derived from Table 11-1. Key to abbreviations is shown on Figure 11-3a. Only plutons of particular interest (as discussed in the accompanying text) are labelled on Figures 11-3b to 11-31. Lines are average trends for calc-alkalic plutons from Gribble (1969). 94

Figure 11-4. Compilation of means and standard deviations for trace elements in the "granitic" phases of the plutons (those containing more than 65% SiO_2). 97

Figure 11-5. Histograms of data for selected trace elements in the "granitic" phases of the plutons. Vertical scale indicates number of samples. 98

Figure 11-6. Cumulative frequency curves for trace element data from "granitic" samples in all plutons of this study. 100

Figure 12-1. Means and standard deviations of major element oxides in "granites" of this study compared to Average and Specialized Granites of Tischendorf (1977). 104

Figure 12-2. Means and standard deviations of trace elements in "granites" of this study compared to Specialized and Average Granites of Tischendorf (1977) and Vingradov (1962) and the granite classification of Tauson and Kozlov (1973). Li data from Chapter 10. 104

LIST OF TABLES

Table 1-1. Statistical data for reference linear regression lines on silica variation diagrams, derived from geochemical data for Huntington Mountain, Kellys Mountain, Cape Smoky, and White Point plutons (n = 168). 5

Table 2-1. Average analyses and standard deviations for the three main phases in the Huntington Mountain pluton. 11

Table 3-1. Average analyses and standard deviations for the four main phases in the Kellys Mountian pluton. 19

Table 4-1. Average analyses and standard deviations for the five main phases in the St. Anns Mountain pluton. 30

Table 5-1. Average analyses and standard deviations for the three main phases in the Cape Smoky pluton. 39

Table 6-1. Average analyses and standard deviations for the four rock types in the White Point pluton. 47

Table 7-1. Average analyses and standard deviations for the three main phases and the minor phases of the Gillis Mountain pluton. 55

Table 8-1. Average analyses and standard deviations for samples from the Deep Cove pluton and related granitic dykes. 62

Table 9-1. Average analyses and standard deviations for samples from the Petit-de-Grat pluton. 68

Table 10-1. Average selected trace element data for samples containing more than 65% SiO_2 (ie "granites"). 73

Table 11-1. Summary tables for trace element data for plutons in this study, showing mean, standard deviation, minimum and maximum values, and coefficient of variation. (a) As, (b) Ba, (c) Cu, (d) F, (e) Pb, (f) Mo, (g) Rb, (h) Sr, (i) S, (j) Sn, (k) U, (l) Zn. 82

Table 11-2. Background values and other statistical data for "granitic" samples from the plutons in this study. Data are derived from cumulative frequency plots of Figure 11-6. A question mark indicates that the value could not be read from the plot, for reasons discussed in the text. ... 96

Table 12-1. Summary of some features of I-type granites (taken from Chappell and White, 1974; White and Chappell, 1977) exhibited by granites of this study. 103

Table 12-2. Selected elemental ratios in Average and Specialized Granites (from sources given in the text) compared to those in "granites" of this study. HG + GD = hornblende biotite granite and granodiorite; LGr = leucogranite; PGr = porphyritic granite; FgGr = fine grained granite. 105

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ABSTRACT

Eight granitoid plutons were mapped and sampled during the summer of 1978 as the first phase of a continuing study of the geology, geochemistry, and economic potential of granitoid plutonic rocks in Cape Breton Island. These included the late Hadrynian-early Cambrian Huntington Mountain, Kellys Mountain, and St. Anns Mountain plutons, the Ordovician-Silurian (?) Cape Smoky pluton, and the Devono-Carboniferous Gillis Mountain, Deep Cove, Petit-de-Grat, and White Point plutons. The first three plutons are broadly similar, consisting of dioritic rocks intruded by major bodies of leucogranite and related granitic rocks. However, the St. Anns Mountain pluton is locally mineralized, whereas the other two apparently are not. The Cape Smoky pluton consists predominantly of biotite granite, with distinctive petrographic features which, like its age, suggest that it is not correlative with the older leucogranites. The Devono-Carboniferous group of plutons displays wide diversity. The Gillis Mountain-Deep Cove plutons are probably co-magmatic, shallow-level intrusions, with pervasive Cu-Mo mineralization. The Petit-de-Grat pluton is a cataclased leucogranite, tectonically emplaced. The White Point pluton is a deep-level intrusion composed of muscovite-biotite granite.

Major and trace element data from these plutons are generally consistent with their petrographic features. White Point pluton clearly stands out as a peraluminous "S-type" granite, whereas the others show features, both petrographic and chemical, which have been ascribed to "I-type" granitoid plutons. Only the Gillis Mountain and Deep Cove plutons show strong evidence of mineralization in their chemical data. The data indicate that none of these plutons has significant potential for Sn-U mineralization. Their petrological features are generally appropriate for Cu-Mo-W mineralization, and comparision between the Gillis Mountain-Deep Cove plutons and the other, apparently unmineralized or only locally mineralized plutons indicates that Ba, Cu, Mo, Pb, and Zn are the best indicators of the presence of mineralization.

NSDME Paper 82-1

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CHAPTER 1
INTRODUCTION

PURPOSE OF THE STUDY

The association of important economic mineral deposits with intrusive granitoid igneous rocks is well known in many areas of the world. In 1978, a study of the geology and geochemistry of granitoid plutons in Cape Breton Island was initiated. The ultimate purpose of this project is to assess the economic potential of these plutons using aspects of their petrology and/or geochemistry as indicators of mineralization. Simultaneously valuable information will be obtained concerning lithology, geochemistry, age and petrogenesis of these plutons, about which very little is currently known. These data will contribute to a better understanding of the geology and geological evolution of Cape Breton Island.

This report is concerned with the results of the first phase of this project which involved mapping and petrological studies of eight plutons beginning during the summer of 1978. These plutons were selected to represent different ages, geographic areas and lithologies (both mineralized and apparently unmineralized). In addition to providing previously unknown information on these specific plutons, this pilot study shows that certain major, minor and trace elements may be indicators of economic mineralization in granitoid rocks of Cape Breton Island. It provides a group of "type plutons" to which others can be compared during further studies.

SELECTION OF PLUTONS FOR STUDY

Granitoid plutons are abundant in Cape Breton Island (Fig. 1-1). Relatively little geological work has been done on these plutons, but they are known to be of varied lithology and ages, and some are known to be mineralized or associated with mineralization. For the initial phase of this project, six plutons, ages of which were reasonably well known (Cormier, 1972), were selected for detailed mapping and sampling. These include three Late Precambrian-Cambrian plutons, two of which are apparently unmineralized (Huntington Mountain and Kellys Mountain) whereas the third, St. Anns Mountain, has associated Cu-Mo mineralization (Fig. 1-1). The Cape Smoky pluton, which is not known to be mineralized, was selected as a possible Ordovician pluton. Gillis Mountain pluton was chosen on the basis of its Devonian age, Cu-Mo mineralization, and location in southeastern Cape Breton Island. The White Point pluton in northern Cape Breton Island was included as a Devonian pluton with no known mineralization. In addition to these six which were studied in detail, mapping and sampling were done at the small Devono-Carboniferous Petit-de-Grat and Deep Cove plutons (Fig. 1-1).

FIELD METHODS

Two parties of two persons each undertook the mapping and sampling of the selected plutons, which required an average of three to four weeks per pluton. Mapping was done at the scale of 4" to 1 mile, using maps of the Nova Scotia Department of Lands and Forests Crownland Forestry Series as base maps. Mapping was extended into country rocks adjacent to the plutons in order to assess contact relationships.

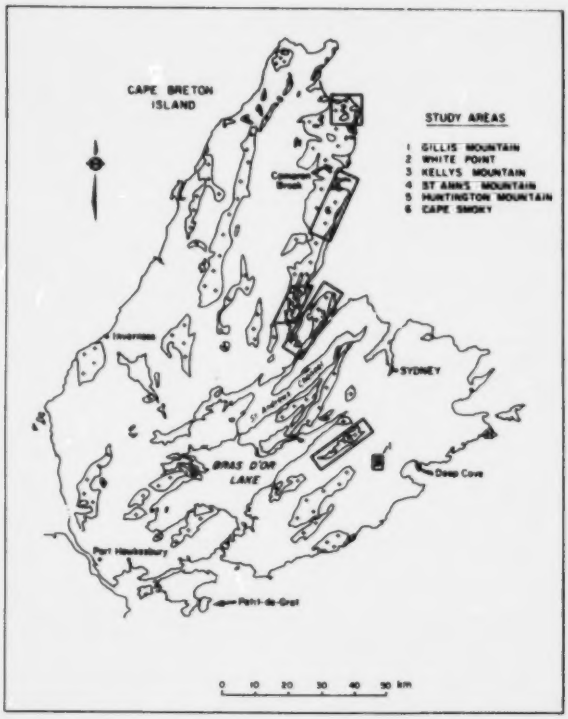


Figure 1-1. Distribution of granitoid rocks in Cape Breton Island and location of plutons described in this report.

Large samples weighing 1 to 3 kg were collected for chemical analysis. The size increased with increasing grain size and amount of weathered rind. Excessively weathered samples and samples which did not appear to be representative of rocks in the vicinity of the sampling site were not used for chemical analysis. Sampling sites were chosen to provide reasonable geographic distribution given a limit (imposed by budgetory factors) of approximately 50 samples for analysis from each pluton. In addition, smaller samples were collected for reference and petrographic studies, making a total of 100 to 200 samples from each pluton.

Distribution of sampling sites was determined to a considerable extent by outcrop availability as well as distribution and relative abundance of igneous phases. All six plutons mapped in detail have large areas of no bedrock exposure which could not be sampled.

LABORATORY METHODS

Thin sectioning, staining of slabs for potassium feldspar (Appendix A), powder preparation (Appendix B), and most chemical analyses were done under contract in the Laboratory for the Investigation of Minerals (CLIM) at the Atlantic Industrial Research Institute, Technical University of Nova Scotia, under the supervision of M. A. K. Grice. Major element analyses of 25 samples from Gillis Mountain pluton were done by A. M.

O'Beirne in the Department of Geology, Acadia University.

The analytical methods and their accuracy and precision are described in Appendix B. Samples were analyzed for the major elements Si, Ti, Al, Fe, Mg, Mn, Ca, Na, K, and P, as well as H_2O^+, H_2O^-, CO_2, and Fe^{2+}. They were also analyzed for the following minor and trace elements: As, Ba, Cu, F, Mo, Pb, Rb, S, Sn, Sr, U and W, following recommendations by W. H. Poole and others (written communication to D. A. Murray, Acting Director, Nova Scotia Department of Mines, 1978). In addition, approximately 10 samples from each pluton were selected as representative on the basis of petrography and these analytical results, and were subsequently analyzed for Sb, B, Be, Bi, Cd, Co, Li, Ni, Nb, Y, and Zr.

Samples from five plutons were selected on the basis of suitable Rb and Sr contents for dating by the Rb/Sr method by R. F. Cormier, St. Francis Xavier University (Cormier, 1979, 1980).

PRESENTATION OF DATA

Each of the six major plutons of this study, as well as Deep Cove and Petit-de-Grat plutons, is discussed under the headings Introduction (Location and Access, Size and Exposure, Previous Work), Geological Setting, Plutonic Rocks (Introduction, Petrography, Geochemistry, Economic Geology, Age) and Summary. A geological map based primarily on the results of this investigation is presented for each pluton. Sampling sites are indicated on each map.

Petrographic descriptions of the representative samples selected for chemical analyses are tabulated in Appendix C. Summary petrographic descriptions for the phases and subphases of each pluton are presented in the text of the report. The rocks are named using the ternary system of Streckeisen (1976), shown for reference in Figure 1-2.

All chemical data together with CIPW normative mineralogies are listed in Appendix D. Average chemical analyses for the main phases and subphases of each pluton are presented in the body of the report. The data are discussed for convenience under the headings Major Element Geochemistry (including SiO_2, TiO_2, Al_2O_3, Fe_2O_3T, MnO, MgO, CaO, K_2O, Na_2O and P_2O_5) and Trace Element Geochemistry (including As, Ba, Cu, F, Pb, Mo, Rb, Sr, S, Sn, U, Zn), although by strict definition some of both the first and second groups are minor elements. Tungsten levels are below the detection limit of 4 ppm in all analyzed samples and hence this element is not included in the presentation of the data.

The chemical data are displayed on binary variation diagrams, on which each oxide or element is plotted against SiO_2. This method of data display was selected because SiO_2 contents correlate well with petrographic variations in these plutons, and this parameter avoids any in-

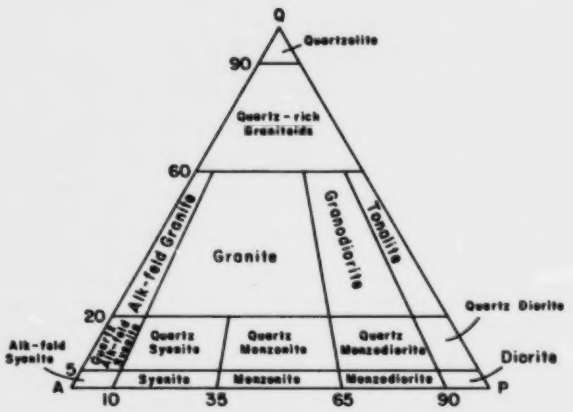


Figure 1-2. Nomenclature for granitoid rocks used in this report (after Streckeisen, 1976). Q = quartz; A = alkali feldspar; P = plagioclase.

ference concerning co-magmatism or genetic relationship of the igneous phases. For ease of comparison, all plots for each oxide or element are drawn on the same scale. "Best-fit" linear regression lines derived from data for Huntington Mountain, Kellys Mountain, Cape Smoky and White Point plutons are shown on each diagram. The purpose of these lines is simply to provide visual reference when comparing one pluton to another. Data from Gillis Mountain, Deep Cove, St. Anns Mountain and Petit-de-Grat plutons were omitted in the construction of these best-fit lines due to some obviously anomalous aspects of their geochemistries. The relevant statistical data for these linear regression lines are presented in Table 1-1. Some oxides and elements, most notably Na_2O, obviously do not have linear correlations with SiO_2. However, the line still provides a useful visual reference.

Also shown for comparison on the variation diagrams are curves indicating the distribution of the elements or oxides in plutonic rocks of normal calc-alkaline sequences from the compilation of Gribble (1969).

The normative Q-Or-Ab+An ternary diagram is presented for comparison with the modal mineralogy. However, it should be kept in mind that these diagrams are not strictly comparable because the normative plot includes all soda in the plagioclase, whereas some is present in alkali feldspar in the modal plot. This usually results in a shift towards the plagioclase corner on the normative plot compared to the modal plot.

The limited analytical data for Sb, B, Be, Bi, Cd, Co, Li, Ni, Nb, Y, and Zr for all plutons are presented and discussed in Chapter 10.

It is beyond the scope of this report to discuss the petrogenesis, origin or tectonic significance of these plutons, and hence these aspects are not considered.

Table 1-1. Statistical data for reference linear regression lines on silica variation diagrams, derived from geochemical data for Huntington Mountain, Kellys Mountain, Cape Smoky and White Point plutons (n = 168).

	Mean	Std.Dev.	Low Value	High Value	R	Slope	Intercept
SiO_2	68.56%	9.03	46.65	77.89	-	-	-
TiO_2	0.48	0.57	0.04	2.67	-0.92	-0.06	4.49
Al_2O_3	14.51	2.09	11.09	22.05	-0.87	-0.20	28.34
Fe_2O_3T	3.37	3.06	0.72	12.69	-0.96	-0.33	26.14
MnO	0.06	0.06	0.005	0.25	-0.92	-0.01	0.49
MgO	1.54	2.07	0.02	8.12	-0.95	-0.22	16.55
CaO	2.98	2.61	0.51	11.48	-0.97	-0.28	22.08
K_2O	3.38	1.34	0.32	5.68	0.85	0.13	-5.30
Na_2O	3.82	0.66	1.90	5.75	0.23	0.02	2.67
P_2O_5	0.11	0.10	0.02	0.45	-0.83	-0.01	0.73
	ppm						
As	6	3	1	18	-0.08	-0.03	8.23
Ba	501	285	7	1350	0.23	7.28	1.00
Cu	15	23	1	122	-0.80	-1.98	148.39
F	460	200	150	1630	-0.14	-3.00	684.00
Mo	2	1	0	8	-0.02	0.00	2.34
Pb	17	21	2	214	0.19	0.42	-11.79
Rb	137	82	18	475	0.59	5.36	-225.50
S	260	560	10	3900	-0.61	-40	2840
Sn	3	2	1	27	0.11	0.03	0.60
Sr	225	175	11	1350	-0.53	-10.33	932.63
U	2	2	0.2	12	0.44	0.09	-3.65
Zn	46	28	5	138	-0.85	-2.65	226.94

CHAPTER 2
HUNTINGTON MOUNTAIN PLUTON

INTRODUCTION

LOCATION AND ACCESS

Huntington Mountain is part of the East Bay Hills which form a plateau 150 m in elevation southeast of Bras d'Or Lake (Fig. 1-1). Intrusive rocks of the Huntington Mountain pluton extend from Mineral Spring Road northeast across Huntington Mountain to Gibbons Brook (Fig. 2-1).

Access to the northeastern end of the study area is good as a number of roads and trails traverse the pluton. The southwestern part of the study area is accessible from Mineral Spring Road. An electrical power line traverses the length of the pluton.

SIZE AND EXPOSURE

The Huntington Mountain pluton is roughly wedge-shaped with a maximum width of 3.2 km in the Huntington Mountain area narrowing to less than 0.5 km at the southwestern extremity. It is 15.7 km in length and covers an area of approximately 32 km^2.

Excellent outcrops occur in the central and eastern areas of the pluton. On top of the plateau, (northwest of the power line on Figure 2-1), exposure is generally poor due to dense softwood cover and swampy terrain.

PREVIOUS WORK

The study area was mapped by Weeks (1954) at a scale of 1 inch to 1 mile. He described the pluton as granitic with associated small bodies of andesite, basalt and gabbro which he interpreted to be younger than the granitic rocks. No detailed mapping of the granitic rocks or petrographic or geochemical studies were done.

The existence of significant lead deposits in the Carboniferous rocks in the Salmon River Valley 10 km south of the pluton led to extensive exploration of areas which overlap the southwestern part of the Huntington Mountain pluton. However, little attention was given to the granitoid rocks. Results of these surveys are in Assessment Files at the Nova Scotia Department of Mines and Energy, Halifax.

GEOLOGICAL SETTING

The Huntington Mountain pluton intruded a steeply dipping sequence of metamorphic rocks which consist predominantly of fine grained meta-tuffs and chloritic schists with lesser massive and porphyritic flows, volcanic breccias and quartzites. Weeks (1954) assigned these rocks to the Fourchu Group of probable Late Precambrian or early Cambrian age as they apparently are overlain conformably by Lower Cambrian sedimentary rocks.

In the study area the regional metamorphic grade of the Fourchu Group does not exceed lower greenschist facies. A well developed penetrative cleavage is common in the fine grained meta-tuffs and chloritic schists. The Huntington Mountain pluton has a narrow contact metamorphic aureole immediately adjacent to defined or assumed contacts, where the country rocks are very hard, fine grained hornfelses which are commonly cherty. Also in these areas, rocks of the Fourchu Group contain abundant dykes and pods of pink coarse grained granite, porphyritic granite and aplite. Less abundant small pods (dykes?) of diorite have also intruded the country rocks, and chilling of diorite of the Huntington Mountain pluton against massive flows and tuffs of the Fourchu Group is apparent in exposures on Chapel Road (Fig. 2-1).

Along its southeastern margin the Huntington Mountain pluton is in contact with the coal-bearing grey to red sandstones and conglomerate which Weeks (1954) assigned to the Morien Group. These rocks are generally gently dipping and unmetamorphosed. Locally they nonconformably overlie the igneous rocks of the Huntington Mountain pluton. However, generally they are inferred to be in fault contact with the plutonic rocks. This is based on a definite steepening in dip in the sedimentary rocks from less than 25° to 50°-90° within 0.5 km of the pluton. Within the pluton, proximity to the inferred fault is indicated by darkening of the pink colour of the granite which does not appear to be related to any change in composition.

Mafic dykes are common in all pre-Carboniferous rock units in the Huntington Mountain area (Fig. 2-1).

PLUTONIC ROCKS

FIELD RELATIONS

The Huntington Mountain pluton consists of a dioritic complex, porphyritic quartz monzonite, pink coarse grained biotite granite and leucogranite, and fine grained aplite. The oldest phase of the pluton is the dioritic complex which occurs in two areas, one centred on Huntington Mountain and the other south of Sgurra Bhreac (Fig. 2-1). Several smaller isolated bodies (dykes ?) of dioritic rocks were also observed in the Fourchu Group in the study area. The presence of these small intrusions in the country rocks suggests that the main dioritic bodies may have been formed by multiple intrusions resulting in the complex textural and compositional variations observed over short distances. The dioritic complex consists predominantly of diorite and quartz diorite characterized by variations in grain size, texture, and modal composition. In places, fine- to medium-grained diorite has been intruded and brecciated by a coarse grained phase of similar composition. Locally a gradational relationship occurs between these phases. Also present are areas of leucodiorite, quartz monzodiorite, quartz monzonite, and appinite (pegmatoid in texture) which occur in both sharp and gradational contact with the more abundant dioritic rocks. They are interpreted to be later-stage differentiates of the dioritic parent magma.

The dioritic complex was intruded by coarse grained pink biotite granite grading to leucogranite which forms a large body comprising about 60 per cent of the area of the pluton. At the northern tip of the pluton, the texture is graphic (Fig. 2-1). Scattered small pegmatoid vugs

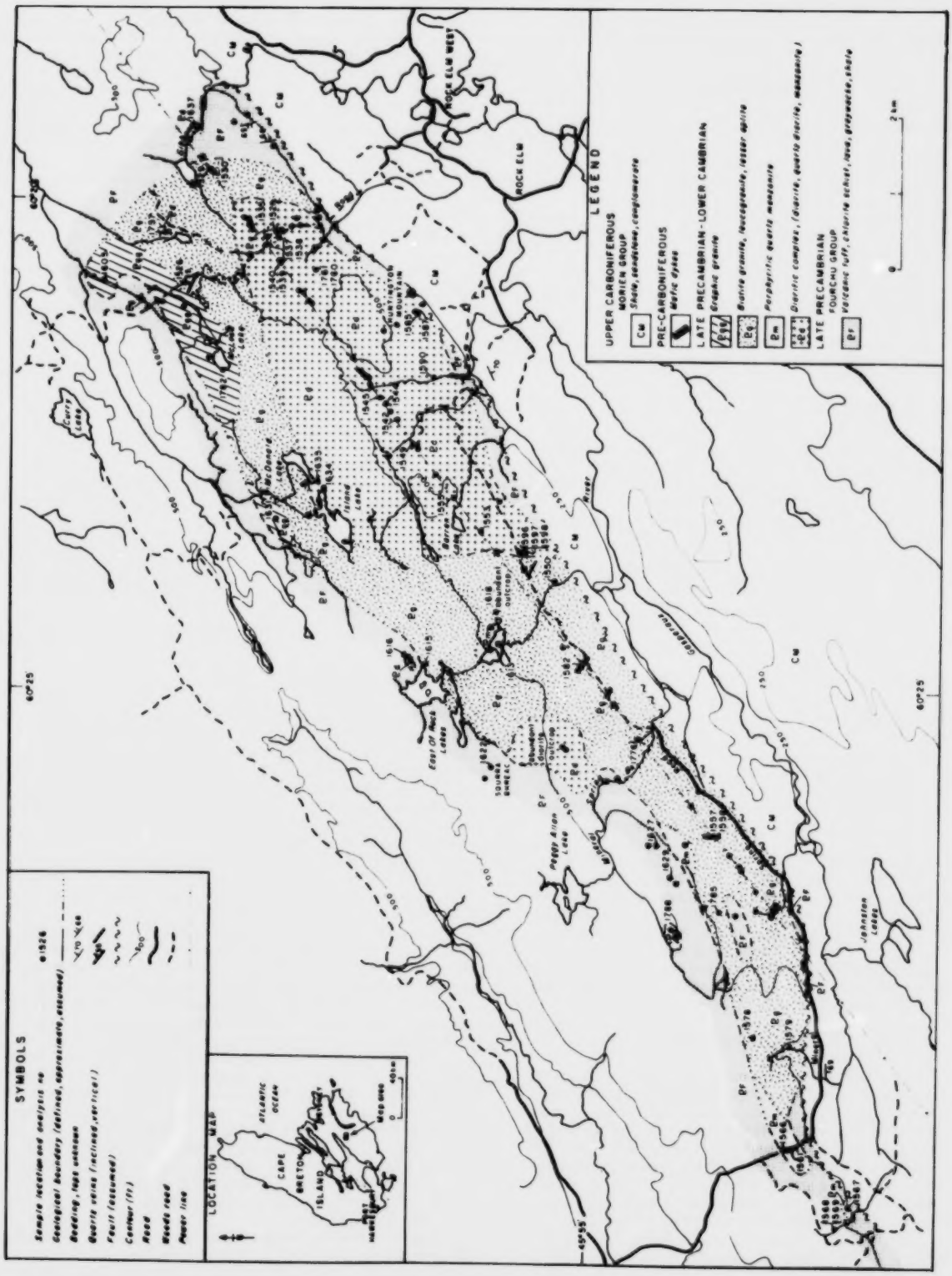


Figure 2-1. Geology of the Huntington Mountain pluton.

filled with quartz and orthoclase occur within the granitic phase, as well as aplitic dykes. Abundant dykes and pods of granite are present within the areas mapped as dioritic complex especially near the granite-diorite contacts where contact zones of stoping and veining occur rather than simple sharp contacts. These zones extend over approximately 200 m and contain outcrops of both granite and diorite, as well as diorite intruded by granite and aplite. Large angular xenoliths of diorite are common in the granite.

Three small bodies of porphyritic quartz monzonite are present in the central and southwestern areas of the pluton. Contact relationships of this phase with the other phases of the pluton were not observed so its exact position in the intrusive sequence is not certain. However, dykes of felsic porphyry similar in composition to the porphyritic quartz monzonite have intruded the dioritic complex, and the porphyritic quartz monzonite is intruded by pink fine grained aplites similar to those associated with the granites. As this aplitic phase is probably a late differentiate of the granite, the porphyritic quartz monzonite is inferred to be earlier than or approximately contemporaneous with the granite.

PETROGRAPHY

Dioritic Complex

As previously described, the dioritic complex includes diorite, quartz diorite, quartz monzodiorite and quartz monzonite (Fig. 2-2a) although diorite and quartz diorite comprise about 80 per cent of the area mapped as dioritic complex. Textural variations within these rock units are complex.

In thin section the fine- to medium-grained diorite and the coarse diorite have the same mineralogy and texture. They are subophitic to hypidiomorphic granular and consist of andesine (usually zoned), and hornblende and/or clinopyroxene. Hornblende is the dominant mafic mineral. Biotite and chlorite occur as alteration products of hornblende and pyroxene. Plagioclase is commonly saussuritized especially in the more calcic cores of zoned laths. The diorite grades to quartz diorite with increasing abundance of interstitial quartz. It grades to leucodiorite, quartz monzodiorite, and quartz monzonite with decreasing abundance of mafic minerals and increasing amounts of interstitial perthitic orthoclase. The appinite consists of plagioclase and euhedral hornblende in pegmatoid texture.

Porphyritic Quartz Monzonite

The porphyritic quartz monzonite is purple-pink in hand specimen. It consists of phenocrysts of subhedral plagioclase and anhedral quartz and hornblende in a fine grained groundmass of quartz, plagioclase and orthoclase. The plagioclase (An30-35) is moderately saussuritized especially in the calcic cores of zoned laths. Quartz occurs as rounded grains with resorbed boundaries. Hornblende is extensively altered to chlorite.

Biotite Granite and Leucogranite

The coarse grained pink biotite granite and leucogranite comprise about 60 per cent of the Huntington Mountain pluton. The biotite granite is distinguished from leucogranite by a higher mafic content although otherwise they are similar in texture and composition (Fig. 2-2a). The pink colour is due to hematitic staining of both feldspars.

North of Huntington Mountain, in the area of McLeod Lake (Fig. 2-1), the leucogranite displays a medium grained graphic texture and has been mapped as graphic granite. This subphase is gradational into the typical coarse grained pink leucogranite. It may be the result of eutectic crystallization perhaps near the roof of the pluton.

In the area about 1 km west of the large inlier of the Fourchu Group, near the southwestern end of the pluton, outcrops of porphyritic granite were found containing phenocrysts of plagioclase. This variant could not be mapped due to poor exposure.

The biotite granite contains 5 to 8 per cent mafic minerals and the leucogranite less than 5 per cent. Quartz (20% to 50%), orthoclase (20% to 50%), and plagioclase (30% to 40%) comprise the major mineralogy. The quartz is anhedral and commonly displays slight undulatory extinction. Plagioclase (An_{25-35}) is generally partially altered to epidote and white mica. Slight compositional zonation is common with cores more altered. Orthoclase is perthitic and occurs as medium to coarse anhedral grains. Biotite is the dominant mafic mineral, but is largely replaced by chlorite.

The fine grained aplitic dykes have granophyric texture with few or no mafic minerals.

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies are presented in Appendix D. Average analyses for the dioritic complex, the porphritic quartz monzonite, and the leucogranite (including biotite granite, graphic granite, and aplite) are presented in Table 2-1. The data are displayed on silica variation diagrams (Fig. 2-3) together with linear regression lines derived from Cape Breton Island plutons and Gribble (1969).

The **dioritic complex** shows considerable range in chemical characteristics as anticipated from the petrographic variations within the unit. Many of the analyzed samples are mafic in terms of silica contents. The most felsic sample is quartz monzonite with more than 67 per cent silica. The samples show trends of increasing K_2O and decreasing Al_2O_3, TiO_2, MgO, Fe_2O_3T, CaO, MnO, and P_2O_5 with increasing SiO_2. Scatter in TiO_2 and P_2O_5 is related to varied abundances of sphene and apatite in the rocks of the dioritic complex.

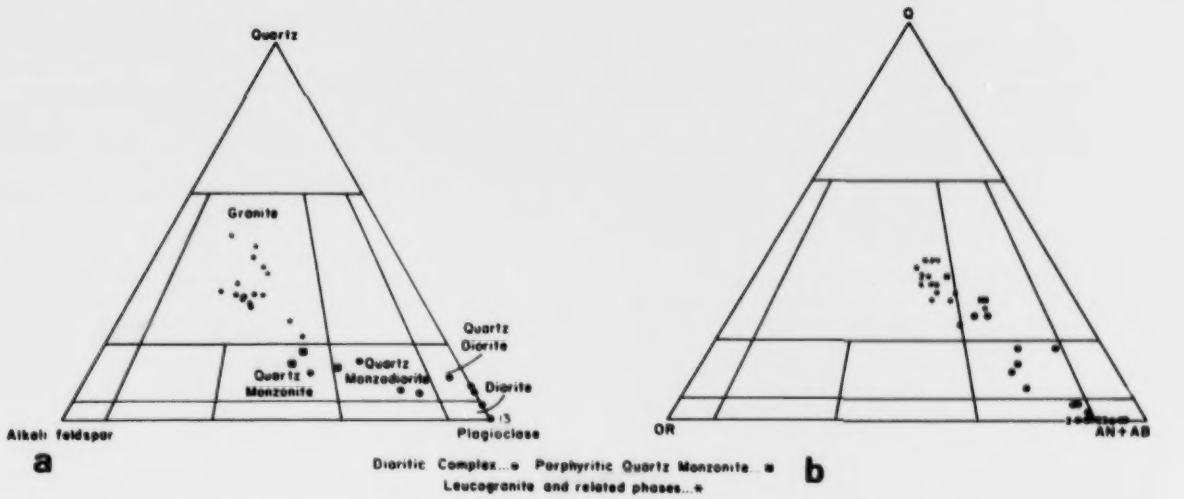


Figure 2-2. Modal mineralogy (a) and normative mineralogy (b) for Huntington Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; An + Ab = normative anorthite plus albite.

The **porphyritic quartz monzonite** is generally the more mafic dioritic complex and the more felsic leucogranite.

The **leucogranite** is an extremely felsic rock with low contents of Fe_2O_3T, MnO, MgO, CaO, P_2O_5 and TiO_2. It is high in K_2O and low in Al_2O_3 compared to the dioritic rocks, but Na_2O values are similar. The biotite granites are only slightly less felsic than the leucogranites and aplites.

The relationships between the major oxides and SiO_2 in the phases of the Huntington Mountain pluton are typical of calc-alkalic plutonic rocks as shown by comparison with the regression line from Gribble (1969) in Figure 2-3. The patterns are similar to those in other plutons of this study, as discussed in Chapter 11.

All samples are saturated or oversaturated with silica and normative Q-Or-Ab+An (Fig. 2-2b) is broadly similar to modal Q-K-P (Fig. 2-2a) with the exception of the porphyritic quartz monzonite which has considerably more normative than modal quartz.

Trace Element Geochemistry

Average trace element data for the rock units of the Huntington Mountain pluton are presented in Table 2-1. The data for all analyzed samples are listed in Appendix D and displayed in Figure 2-4. It is clear that trace element abundances and patterns in the Huntington Mountain pluton are generally similar to those in other "unmineralized" plutons of this study, and in typical calc-alkalic plutonic rocks as presented by Gribble (1969). The main features are discussed below, with the elements arranged in alphabetical sequence. Tungsten values are below the detection limit of 4 ppm in all samples.

Arsenic contents are similar in all phases, showing no significant correlation with SiO_2. It is probable that the actual levels of As are somewhat less than shown due to analytical uncertainty (see Appendix B).

Barium shows broad scatter, but the pattern is typical for some calc-alkalic rocks, generally increasing from the mafic to intermediate rocks and then decreasing in the granitic samples (de Albuquerque, 1971).

Copper values are low and somewhat scattered, but show a definite negative correlation with SiO_2.

Fluorine contents are varied and show no strong correlation with SiO_2. However, most samples of the leucogranite and associated phases have lower contents of F than most samples from the dioritic complex. They do not follow the pattern suggested by Gribble (1969), but are similar to samples from other plutons of the present study.

Lead values are uniformly low, with a tendency toward slightly higher values in the more felsic samples.

Molybdenum values are generally low and show no significant increase with increasing SiO_2. Scatter between 1 and 4 ppm may be due to analytical uncertainty at such low concentrations.

Rubidium shows a broad positive correlation with SiO_2. However, there is considerable scatter, especially in the felsic rocks.

Strontium shows a good negative correlation with SiO_2.

Sulphur values show considerable spread, especially in the dioritic complex, but are generally lower in the more felsic rocks.

Tin values tend to increase slightly with increasing SiO_2, but are low in all analyzed samples.

Uranium contents increase with increasing SiO_2 and show considerable range in the felsic samples. Values tend to be higher in the later samples than in felsic samples from other plutons in Cape Breton Island (see Chapter 11).

Table 2-1. Average analyses and standard deviations for the three phases in the Huntington Mountain pluton.

	Dioritic Complex (n = 21)		Porphyritic Qtz Monzonite (n = 3)		Biotite granite Leucogranite (n = 17)	
SiO_2	52.85	± 6.10	71.33	± 1.27	74.44	± 2.25
TiO_2	1.60	0.48	0.32	0.08	0.24	0.08
Al_2O_3	17.02	1.73	13.99	0.86	12.73	1.19
Fe_2O_3	9.04	2.34	2.75	0.18	1.76	0.63
MnO	0.18	0.04	0.06	0.01	0.04	0.02
MgO	4.97	1.95	0.81	0.09	0.44	0.18
CaO	7.09	2.07	2.17	0.59	1.29	0.40
K_2O	1.53	0.89	3.23	0.37	4.26	0.46
Na_2O	3.68	0.70	4.14	0.29	3.88	0.48
P_2O_5	0.30	0.10	0.11	0.02	0.07	0.03
As	6	3	4	1	6	4
Ba	412	261	872	115	632	296
Cu	41	29	8	11	3	2
F	570	140	630	290	550	350
Pb	12	6	11	5	15	5
Mo	2	1	3	1	3	1
Rb	75	48	99	40	201	69
Sr	314	62	164	56	85	37
S	790	690	60	20	310	640
Sn	2	1	2	1	2	1
U	2	2	3	0	5	2
Zn	98	19	38	2	36	11

Zinc shows a moderate to good negative correlation with SiO_2.

ECONOMIC GEOLOGY

An unconfirmed molybdenite occurrence is reported to be associated with pink granite dykes in volcanic rocks near the southwestern end of the Huntington Mountain pluton (Vokes, 1963, p. 220). The location is inadequately described and could not be exactly located during the present study. However, minor arsenopyrite and pyrite were observed in pink granite dykes in the general area mentioned by Vokes.

Minor pyrite and pyrrhotite were observed in a coarse pyroclastic horizon within the Fourchu Group about 50 m from the contact with the Huntington Mountain pluton on Chapel Road (Fig. 2-1). The sulphides occur both as disseminations and as concentrations along fractures in a small outcrop (1 m^2) in the roadbed and may or may not be associated with the pluton.

Other than these very minor occurrences, the Huntington Mountain pluton appears to be unmineralized.

AGE

On the basis of field relations, the Huntington Mountain pluton is younger than the Late Precambrian Fourchu Group and older than the Upper Carboniferous Morien Group.

Five samples of leucogranite and one sample of quartz monzonite from the dioritic complex collected during the study have given a whole-rock, Rb/Sr isochron age of 573 ± 30 Ma with an initial ratio of $^{87}Sr/^{86}Sr$ of 0.7011 ± 0.0060 (Cormier, 1980). This age is similar to the age of 553 ± 25 Ma previously obtained from samples of leucogranite from Kellys Mountain pluton (Cormier, 1972; Keppie and Smith, 1978).

SUMMARY

The Huntington Mountain pluton is a composite intrusion consisting of an older dioritic complex intruded by small bodies of porphyritic quartz monzonite and large masses of coarse grained pink leucogranite grading to biotite granite and graphic granite. Aplite and rare pegmatite occur as veins, dykes and pods within all phases of the pluton and the older country rocks. The pluton is of Late Precambrian-Cambrian age.

The plutonic rocks range from mafic to felsic and show levels and patterns of major and trace element geochemistry broadly similar to typical calc-alkalic plutonic rocks and to other plutonic rocks in Cape Breton Island. No significantly anomalous features are apparent in the geochemical patterns of the pluton, which is not known to have significant mineralization associated with it.

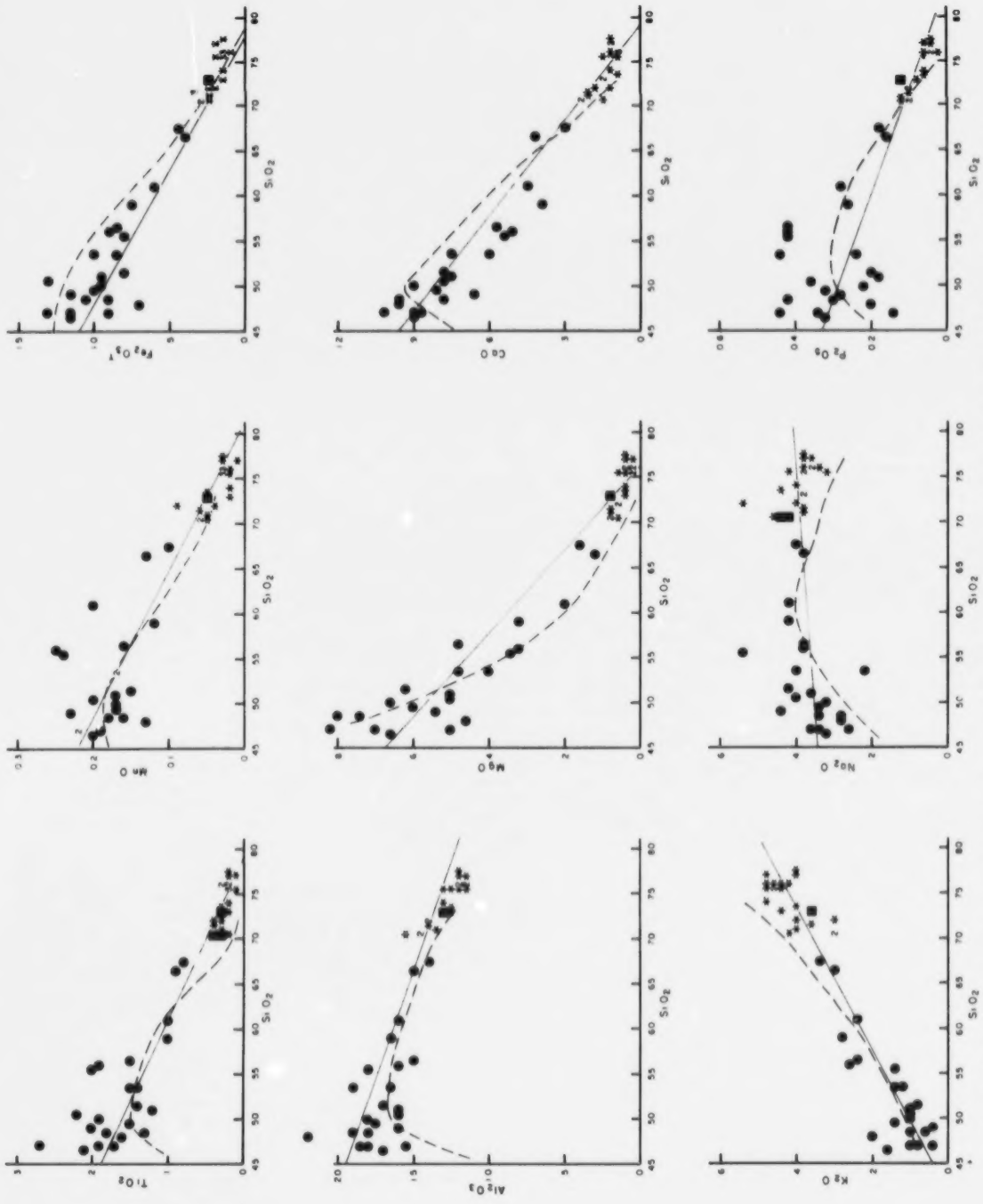


Figure 2-3. Silica variation diagrams for major element oxides in the Huntington Mountain pluton. Symbols as in Figure 2-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

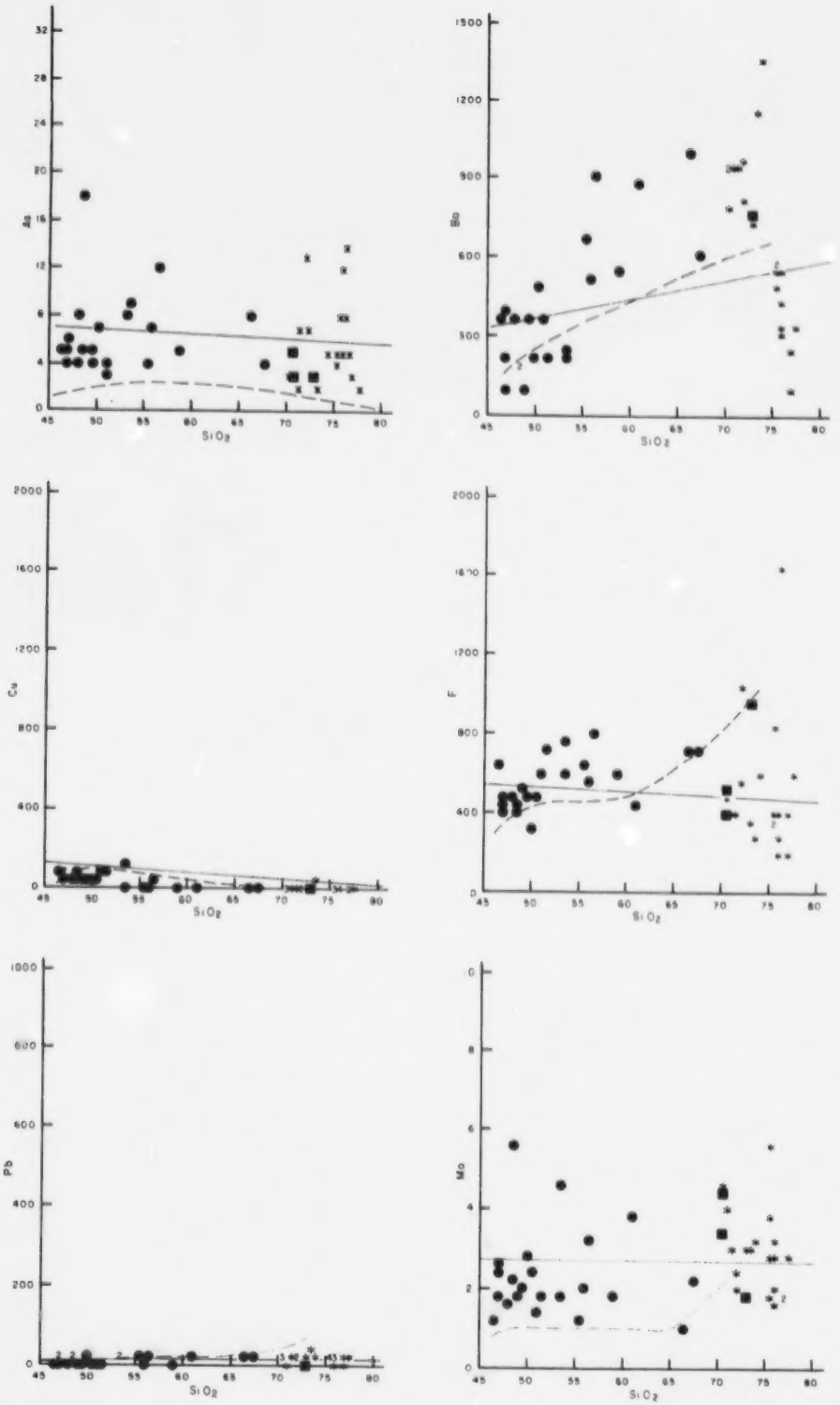


Figure 2-4. Silica variation diagrams for trace elements in the Huntington Mountain pluton. Symbols and lines as in Figures 2-2 and 2-3, respectively.

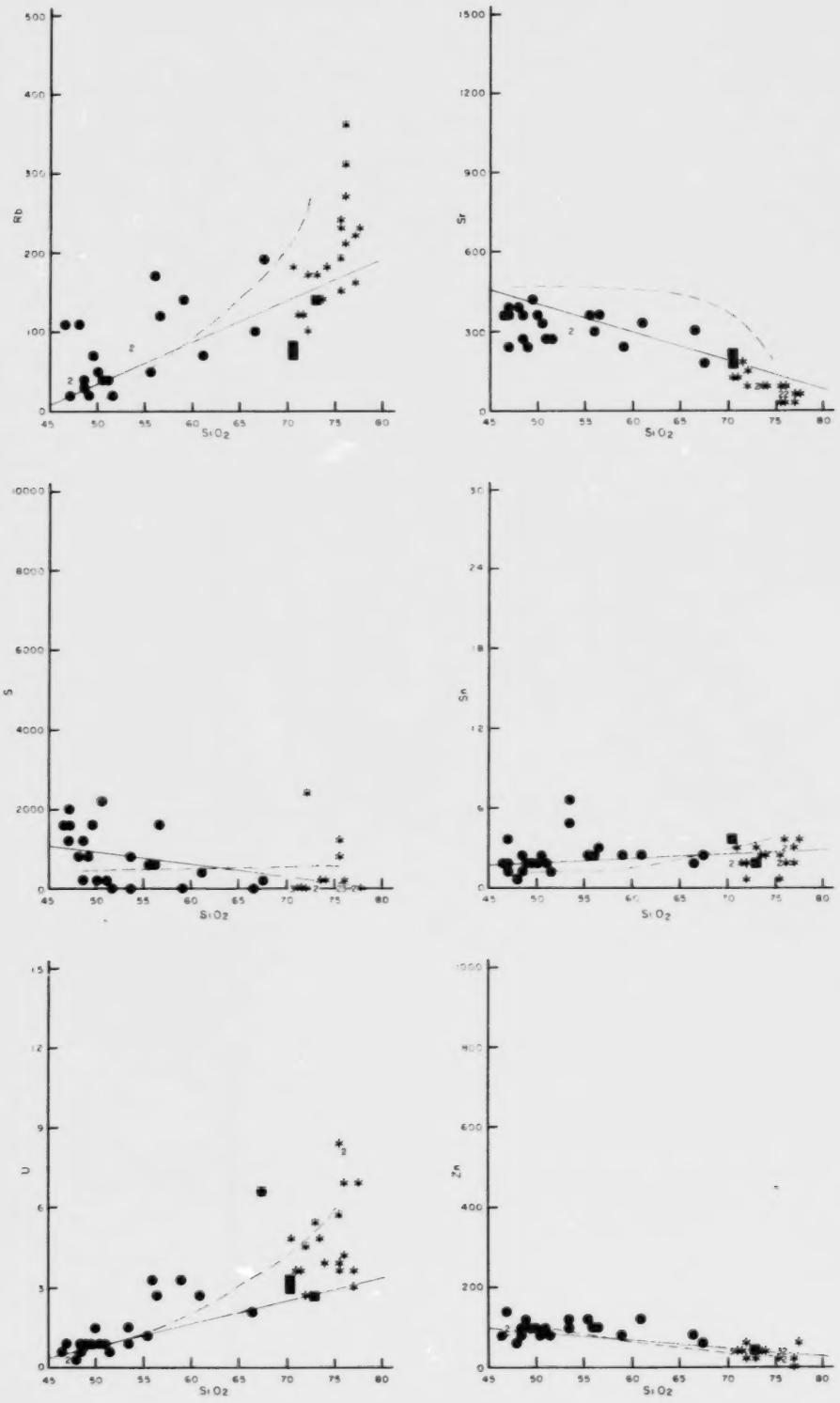


Figure 2-4. Continued.

CHAPTER 3
KELLYS MOUNTAIN PLUTON

INTRODUCTION

LOCATION AND ACCESS

Kellys Mountain forms a peninsula 25 km in length extending into St. Anns Bay between St. Anns Harbour and Great Bras d'Or (Fig. 3-1). The northeastern part of this peninsula (north of the Trans-Canada Highway 105) consists largely of igneous rocks (the Kellys Mountain pluton) and includes about 90 per cent of the igneous rocks on Kellys Mountain (Bell and Goranson, 1938). This area is the focus of the present study and was mapped and sampled in detail (Fig. 3-1). However, some mapping and sampling were also done southwest of the Trans-Canada Highway in order to clarify relationships between the various igenous phases and also to integrate the present mapping with the earlier work of Kelley (1960).

Kellys Mountain rises steeply from sea level to form a broad, rolling peneplain, elevation approximately 300 m. The Trans-Canada Highway crosses the central part of the Kellys Mountain peninsula, and secondary roads provide good access to coastal areas. However, access to the interior of the peninsula is predominantly by foot using streams, crownland survey lines, and old roads and trails.

SIZE AND EXPOSURE

The main mass of the Kellys Mountain pluton forms an elongate body approximately 60 km^2 in area (Fig. 3-1). In addition, smaller irregular bodies and dykes considered to be part of the pluton are abundant in the southern part of Kellys Mountain peninsula.

Outcrop exposure is generally good along roads and shorelines and in streams on the flanks of the Mountain. However, it is poor on the plateau forming the summit which is swampy and covered by thick vegetation and glacial deposits.

PREVIOUS WORK

The Kellys Mountain peninsula was previously mapped by Bell and Goranson (1938) and Kelley (1960, 1967) who showed the geology to be complex. A gneissic terrane of uncertain age and metamorphic rocks of the George River Group have been intruded by plutonic rocks ranging from gabbro and diorite through intermediate phases to granite. These igneous and metamorphic rocks are overlain unconformably by Mississippian and Pennsylvanian sedimentary units.

No petrographic, geochemical, or petrogenetic studies of the igneous rocks were done by previous workers.

An age of 553 ± 25 Ma was determined for the granitic phase of the Kellys Mountain pluton by the Rb/Sr method (Cormier, 1972; Keppie and Smith, 1978).

GEOLOGICAL SETTING

COUNTRY ROCKS

Gneissic Complex

The gneissic complex has been termed the Kellys Mountain Complex by Keppie (1979) who considered it to be part of the pre-Hadrynian basement of Cape Breton Island. It forms much of the central part of Kellys Mountain and is well exposed in roadcuts along the Trans-Canada Highway. It consists primarily of banded biotite gneiss, quartzo-feldspathic gneiss, and migmatite, with minor amphibolite layers. In general the gneissic foliation is steeply dipping and trends approximately northeast; however it is variable, and in places highly contorted. These gneissic rocks have been intruded by various phases of the Kellys Mountain pluton ranging from gabbro to pegmatite, as well as diabase dykes and quartz veins. These intrusive bodies vary in width from a few centimetres to tens of metres and are generally conformable, with sharp contacts. Little if any chilling of the igneous phases of the pluton is apparent near contacts with the gneiss. This is particularly obvious in the case of the predominant pink leucogranite phase which, even in small sills 1 or 2 m in width, is medium- to coarse-grained as in the main body of the pluton.

In general, on the eastern side of Kellys Mountain, the leucogranite and the gneiss have been faulted into juxtaposition, as evidenced by strong shearing in both units for some tens of metres from the contact. However an "injection complex" of granite and gneiss is exposed over a distance of several hundred metres forming the contact between these two units in the stream section south of Bras d'Or Lookoff (Fig. 3-1). Similar, but less extensive zones are present wherever the contact is exposed in the central portion of Kellys Mountain. The gneissic foliation is generally steeply dipping at the contacts and the granite appears locally concordant.

George River Group

The George River Group forms most of the southern quarter of Kellys Mountain peninsula (Fig. 3-1) where it consists primarily of meta-siltstone and meta-greywacke (R. Jamieson, personal communication, 1979). It also occurs in a thin sliver between the Kellys Mountain pluton and the Carboniferous sedimentary rocks forming the northeastern tip of the Kellys Mountain peninsula (Fig. 3-1) where it consists of limestone, dolomite, and quartzite (Bell and Goranson, 1938; Douglas, 1942; Murray, 1972). Contacts between the George River Group and the gneissic complex were not observed, so their relationship is uncertain. However the gneiss is inferred to be older.

Sharp concordant contacts between the leucogranite and marbles of the George River Group are well exposed on the eastern slope of Kellys Mountain north of New Campbellton. The granite does not show effects of chilling near the contacts. Leucogranite dykes were also encountered in drillholes in dolomitic marbles near Cape Dauphin (Murray, 1972). Metasomatic effects were

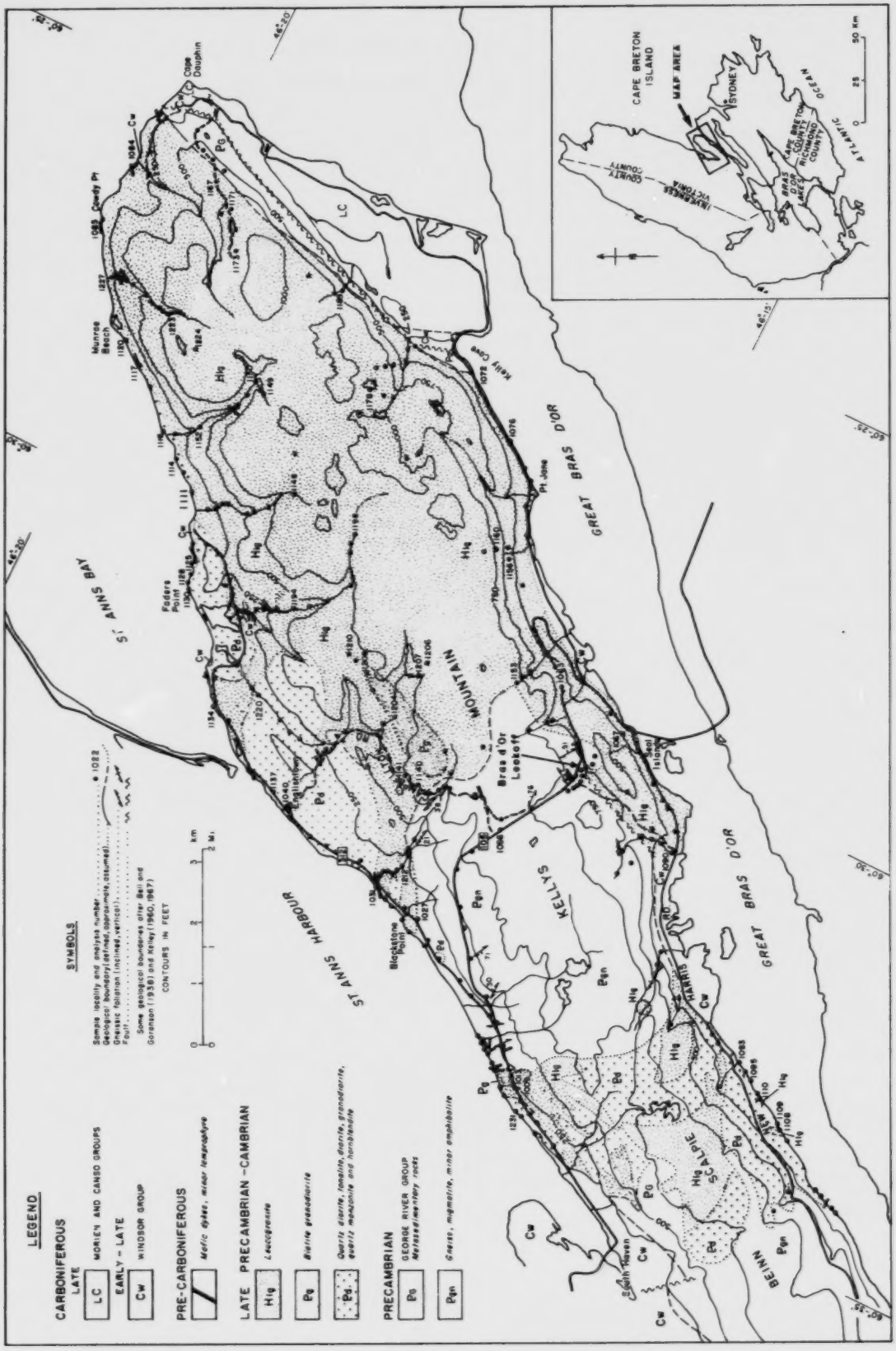


Figure 3-1. Geology of the Kellys Mountain pluton.

not generally observed in the marbles. However, a peculiar metasomatized hybrid rock has been produced in the sliver of George River Group metasedimentary rocks adjacent to the leucogranite in Kellys Cove (Fig. 3-1).

In the southern part of the peninsula, dioritic phases of the pluton as well as leucogranite are in contact with meta-siltstones and meta-greywackes of the George River Group. A lamprophyric dyke obscures the contact on the shore of Great Bras d'Or. However, xenoliths and inliers of metasedimentary rocks occur in diorite along the shore to the east. A complex intermingling of metasedimentary rocks, diorite and leucogranite is exposed in the stream section immediately north of this contact.

Carboniferous Sedimentary Rocks

Scattered occurrences of Carboniferous sedimentary rocks unconformably overlie the metamorphic and igneous rocks of Kellys Mountain (Fig. 3-1). The most spectacular are stromatolitic and thinly laminated limestones of the Windsor Group which are draped over a spheroidally weathered igneous paleotopography in the vicinity of Faders Point (Fig. 3-1). Minor gypsum is also present. Inliers of limestone, locally with abundant arkosic components derived from the underlying granite, also occur in coastal exposures between Cape Dauphin and Mary Rocks. An arkosic conglomerate (Grantmire Member of Bell and Goranson, 1938) derived from the underlying granite is exposed near Cape Dauphin. Limestones also either outcrop or are inferred to be present on low coastal areas on the eastern side of Kellys Mountain, but contacts with the underlying rocks are not exposed.

On the western side of Kellys Mountain, redbeds and conglomerates of the Horton Group (?)are in contact with dioritic phases of the pluton. The contact itself is not exposed, but rocks near the contact are very altered and sheared, suggesting a faulted contact.

Dykes

Mafic dykes up to 4 m in width are common on Kellys Mountain. They were observed in the gneiss, the George River Group, and the plutonic rocks, but none were found in the younger rocks. Near Fader Point, limestones unconformably overlie both diorite and a mafic dyke cutting the diorite. Hence the mafic dykes are assumed to be pre-Carboniferous. The dykes are generally fine- to medium-grained with ophitic texture, and a few are porphyritic. Most have chilled margins. They are generally gabbroic in composition, but some are dioritic.

A lamprophyre dyke 1 m in width occurs at the contact between diorite and the George River Group on the shore of Great Bras d'Or. It contains biotite phenocrysts up to 1 cm or more in diameter in an altered groundmass of feldspar and biotite.

Plagioclase-rich felsite dykes are much less common than mafic dykes. They were found in the gneiss, the dioritic rocks, and the leucogranite, and are generally porphyritic. Their age is unknown.

PLUTONIC ROCKS

FIELD RELATIONS

Plutonic rocks on Kellys Mountain peninsula are divided into two major groups: a petrologically varied assemblage referred to for simplicity as the dioritic complex, and a younger relatively homogeneous pink leucogranite.

The **dioritic complex** occurs mainly in the southern part of the peninsula between the gneiss and the George River Group (Fig. 3-1). Small bodies of dioritic rocks on the northwestern side of the peninsula are interpreted to be part of the same complex on the basis of lithologic similarities. Although quartz diorite is the dominant rock type in these areas, the lithology ranges from gabbro to diorite, tonalite, granodiorite, quartz monzodiorite, and minor quartz monzonite. Two or more of these rock types may be present in one outcrop, in places with sharp contacts and in other places gradational contacts. The variants could not be mapped as separate units. In coastal exposures on St. Anns Bay between Faders Point and Munroe Beach megascopic rhythmic layering with alternating feldspar- and hornblende-rich layers is apparent. The rocks vary gradationally from fine grained to very coarse grained and appinitic. In some places they are porphyritic, with poikilitic hornblende phenocrysts up to 2 cm in length. In other outcrops in the area, fine- to medium-grained diorite has been intruded by granodiorite. This relationship was also commonly observed in the dioritic complex in the vicinity of Englishtown (Fig. 3-1). Outcrops of similar granodiorite are also common in this area, and also to the southwest between Blackstone Point and South Haven. Blocks and boulders of hornblendite also occur on the beach in the latter area, but no definite outcrops were found. In the coastal section along Great Bras d'Or, the dioritic rocks vary gradationally in grain size, texture, and mineralogy, exhibiting the same varieties as previously described.

The **leucogranite** is the most abundant plutonic rock on Kellys Mountain. It forms most of the bedrock north of the Trans-Canada Highway and is also abundant as dykes and irregular bodies in older rocks of the peninsula. Contacts with the various phases of the dioritic complex are always sharp although chilling is rarely obvious. The leucogranite is generally medium- to coarse-grained even in small dykes. However, the area mapped as leucogranite includes irregular bodies and dykes of fine grained, aplitic leucogranite, apparently similar in lithology to the surrounding coarser grained rock. A dyke-like body of this rock at least 30 m in width occurs near Point Jane on Great Bras d'Or, and irregular bodies occur in the area of the summit of Kellys Mountain near the northern end of the peninsula. In the upper parts of stream sections in this area this fine grained leucogranite appears to be mixed with the coarser grained leucogranite, with somewhat gradational contacts. Small pegmatoid patches occur within the fine grained leucogranite. Small quartz-lined cavities were observed at a few localities. Pegmatite dykes occur very rarely, generally associated with leucogranite dykes in the dioritic complex. Aplitic dykes cutting the dioritic complex may be

equivalent to the fine grained subphase of the leucogranite.

The content of mafic minerals (biotite) in the leucogranite varies from negligible to 5 per cent. This variation gives a patchy appearance to the rock in outcrops where it occurs. In addition to this normal variation in biotite content, in two areas within the leucogranite the rocks contain more than 5 per cent biotite and appear distinct from the normal leucogranite. These areas were mapped as biotite granodiorite (Fig. 3-1). Contact relations with normal leucogranite were not observed.

PETROGRAPHY

Dioritic Complex

The dioritic complex is composed of a variety of plutonic rocks containing varying amounts of quartz, feldspar, and mafic minerals. Petrographic descriptions of typical samples are listed in Appendix C, and modal compositions are shown in Figure 3-2a.

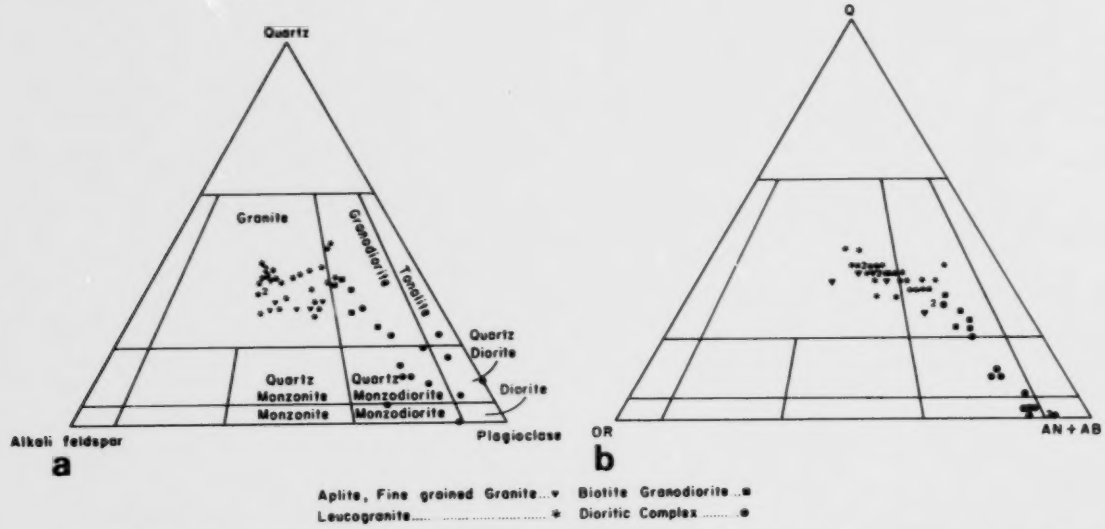


Figure 3-2. Modal mineralogy (a) and normative mineralogy (b) for Kellys Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite.

Texture is typically subophitic consisting of subhedral plagioclase and hornblende with variable amounts of interstitial quartz and alkali feldspar. The plagioclase is commonly zoned, ranging from labradorite to oligoclase, but dominantly andesine (An_{40-45}). The hornblende is pleochroic in shades of green and olive green. Biotite is present in monzodioritic and granodioritic phases. Large interstitial anhedral grains of sphene are generally present. Other accessory minerals include apatite, zircon, and opaques.

Leucogranite

The leucogranite is a distinctive pink to red rock with low content of mafic minerals. Gradational variations in grain size and proportion of mafic minerals are typical of many exposures. On the weathered surface the leucogranite commonly appears porphyritic due to weathering out of anhedral white quartz grains in a pink or red "groundmass". In thin section this "groundmass" generally consists of subhedral plagioclase and anhedral alkali feldspar of grain size similar to that of the quartz, the pink colour being due to hematitic staining of both feldspars. These hypidiomorphic granular textures grade into inequigranular textures in which the anhedral alkali feldspar is distinctly finer grained than the plagioclase or quartz. In a few areas the quartz is distinctly larger than either feldspar and forms true phenocrysts.

Quartz generally comprises 40 to 50 per cent of the rock (Fig. 3-2a). Plagioclase ranges from 30 to 40 per cent and is commonly zoned with compositions about An_{20} in cores, to An_{10} near rims. Orthoclase makes up only 10 to 30 per cent of the rock. It is strongly perthitic. Biotite is the only mafic mineral present. It generally comprises only 1 to 2 per cent of the rock, but in some areas increases to 5 per cent. These biotite-rich patches appear to be irregularly distributed. In most samples the biotite is partially or completely altered to chlorite. Accessory minerals include zircon, apatite, and opaques.

The fine grained (aplitic) subphase of the leucogranite contains similar mineralogy, with orthoclase generally equal in abundance to plagioclase. Many samples contain graphic intergrowths of feldspar and quartz. Mafic minerals are virtually absent.

The biotite-rich subphase tends to contain less orthoclase than the typical leucogranite and many samples are classified as biotite granodiorite (Fig. 3-2a).

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies are presented in Appendix D. Average analyses

for the dioritic complex, biotite granodiorite, leucogranite, and fine grained granite are presented in Table 3-1. The data are displayed on silica variation diagrams (Fig. 3-3) together with linear regression lines derived from Cape Breton Island plutons and Gribble (1969).

Table 3-1. Average anlyses and standard deviations for the four main phases in the Kellys Mountain pluton.

	Dioritic Complex (n = 13)		Biotite Granodiorite (n= 5)		Leucogranite (n = 28)		Fine Grained Granite (n = 8)	
SiO_2	54.39	± 4.51	67.98	± 1.23	74.10	± 2.18	75.04	± 2.11
TiO_2	1.27	0.55	0.66	0.65	0.24	0.02	0.17	0.08
Al_2O_3	17.83	0.78	15.99	0.66	12.81	0.98	12.47	1.49
Fe_2O_3T	7.67	2.55	2.84	0.78	1.59	0.50	1.40	0.68
MnO	0.13	0.03	0.07	0.03	0.03	0.01	0.03	0.01
MgO	4.40	1.81	0.86	0.25	0.47	0.40	0.21	0.19
CaO	7.08	2.47	2.70	0.46	1.43	0.54	1.06	0.35
K_2O	1.41	0.50	2.31	0.23	3.83	0.85	4.52	0.85
Na_2O	3.74	1.00	5.12	0.07	4.00	0.54	0.60	3.95
P_2O_5	0.20	0.08	0.13	0.03	0.07	0.03	0.05	0.02
As	7	± 3	7	± 4	6	± 2	6	± 4
Ba	373	140	373	200	485	268	277	227
Cu	41	34	41	2	3	1	7	4
F	480	160	480	100	460	260	360	100
Pb	9	8	9	4	11	5	15	10
Mo	2	1	2	<1	2	<1	3	2
Rb	51	26	51	13	139	45	186	79
Sr	387	86	387	222	113	81	58	42
S	620	510	620	50	80	70	130	120
Sn	3	2	3	<1	3	2	4	2
U	1	1	1	<1	2	<1	3	<1
Zn	79	20	79	16	22	9	24	15

Samples from the **dioritic complex** show a wide range in chemical characteristics as anticipated in samples ranging from diorite to quartz monzonite (Table 3-1 and Fig. 3-3). The silica contents in the diorites, quartz diorites, and tonalites are surprisingly low, placing these rocks in the mafic rather than intermediate category. High Al_2O_3 is a consistent characteristic of all the rock types. TiO_2 and P_2O_5 show a wide scatter, with high values in samples containing relatively large amounts of sphene and apatite, respectively. Fe_2O_3T, MgO, and CaO show good negative correlation with SiO_2 whereas K_2O shows a good positive correlation (Fig. 3-3). Na_2O values are scattered, but tend to show a positive correlation with SiO_2.

As anticipated from its petrography, the **leucogranite** is fairly homogeneous in major element composition (Table 3-1). High SiO_2 reflects high modal quartz, as these rocks are unusually felsic for granites in which plagioclase is more abundant than alkali feldspar. K_2O and Na_2O contents show an inverse relationship reflecting varying ratios of orthoclase and oligoclase in the rocks. The elements of the mafic minerals (Mg, Fe, Ti, Mn) are of course present in small amounts. There is not enough spread in SiO_2 values within the leucogranite for trends to show up well, but K_2O appears to have a positive correlation and the other oxides a negative correlation with SiO_2.

The **fine grained (aplitic) subphase** of the leucogranite is more felsic than the typical coarser grained leucogranite of which it is probably a differentiate (Table 3-1). It contains higher SiO_2 and K_2O and generally lower contents of the other oxides. However, differences are not large enough to warrant use of separate symbols on the scale of Figure 3-3.

The **biotite granodiorite subphase** is more mafic than the typical leucogranite with lower SiO_2 and K_2O and higher contents of the other oxides.

Major element concentrations and trends in the Kellys Mountain pluton are generally similar to those presented by Gribble (1969) for calc-alkalic plutonic rocks and to those in other plutons of the present study (Fig. 3-3).

All samples are saturated or oversaturated with silica (Fig. 3-2b), and none would be classified as peraluminous.

Trace Element Geochemistry

Average trace element data for the various phases of the Kellys Mountain pluton are summarized in Table 3-1. All data are displayed on silica variation diagrams (Fig. 3-4), together with average trends derived from the "unmineralized" plutons of this study and typical trends for calc-alkalic rocks after Gribble (1969). It is clear that the trace element abundances and patterns in the Kellys Mountain pluton are similar to those in other "unmineralized" plutons of this study and in typical calc-alkalic plutonic rocks as presented by Gribble (1969). The elements are discussed below in alphabetical sequence. Tungsten values are below the detection limit of 4 ppm in all samples and are not discussed here.

Arsenic values show a similar range in all analyzed samples, with little correlation with SiO_2 content. It is probable that the actual As levels are less than shown, as discussed in Appendix B.

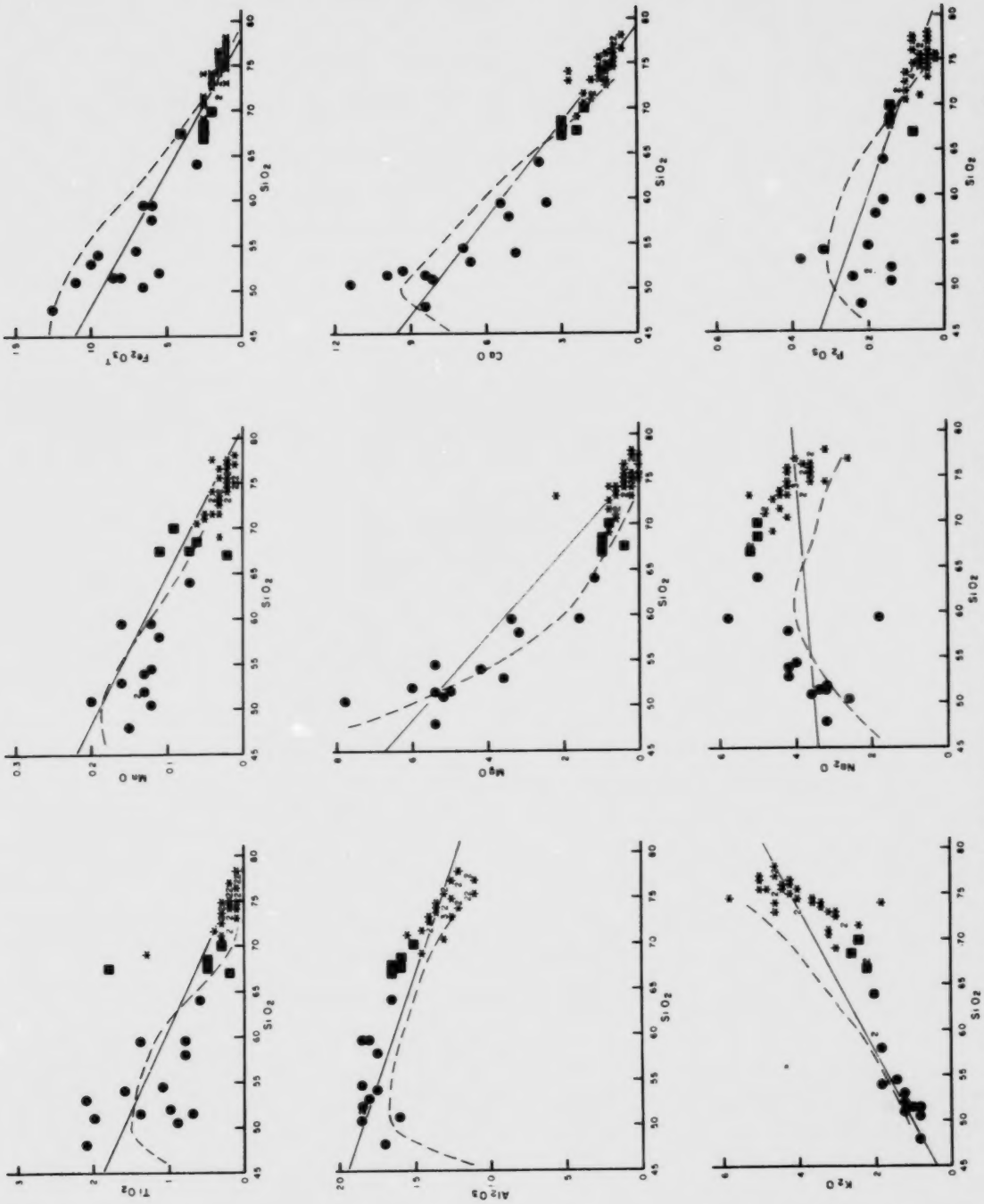


Figure 3-3. Silica variation diagrams for major element oxides in the Kellys Mountain pluton. Symbols as in Figure 3-2 except fine grained granite is grouped with leucogranite. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

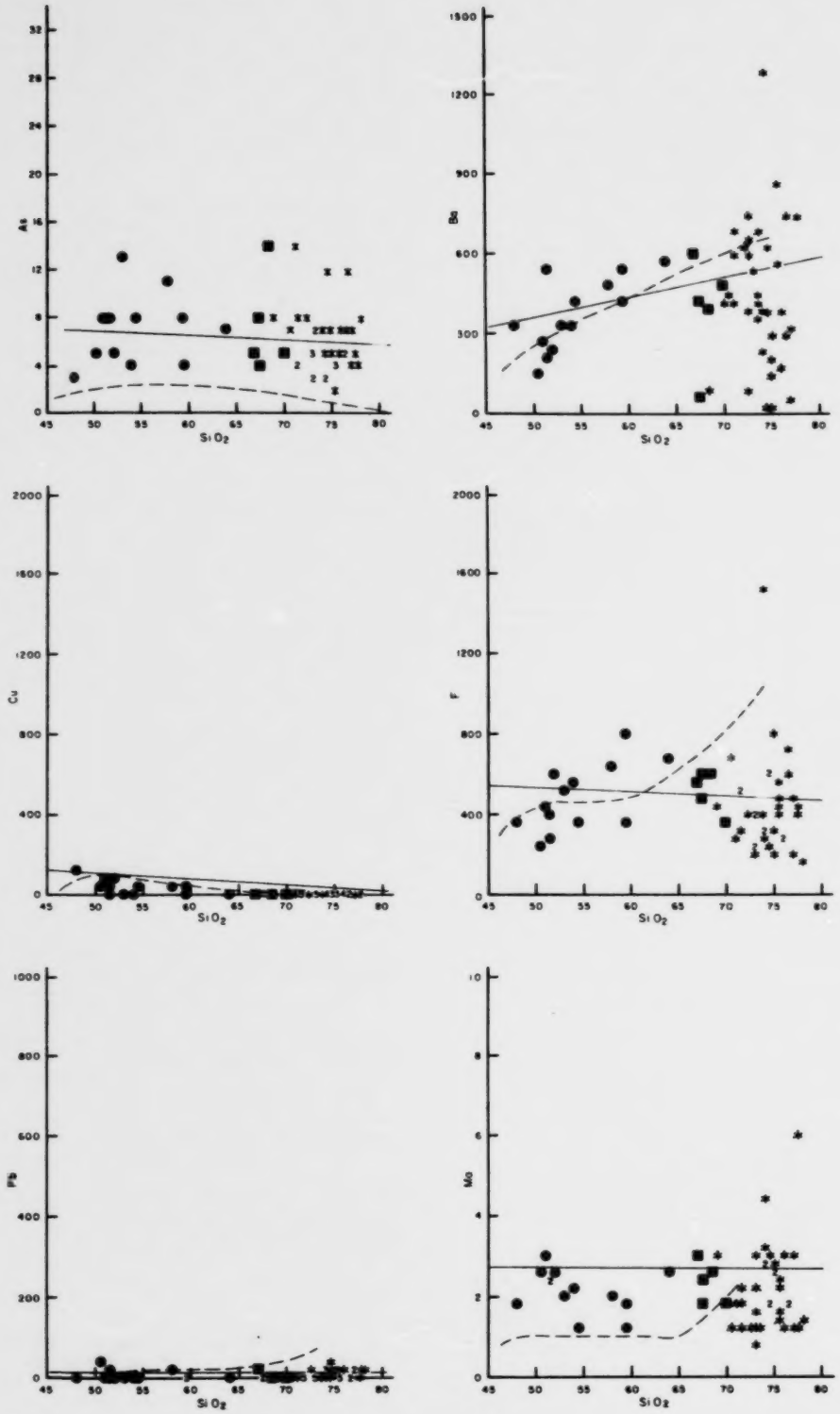


Figure 3-4. Silica variation diagrams for trace elements in the Kellys Mountain pluton. Symbols and lines as in Figures 3-2 and 3-3, respectively.

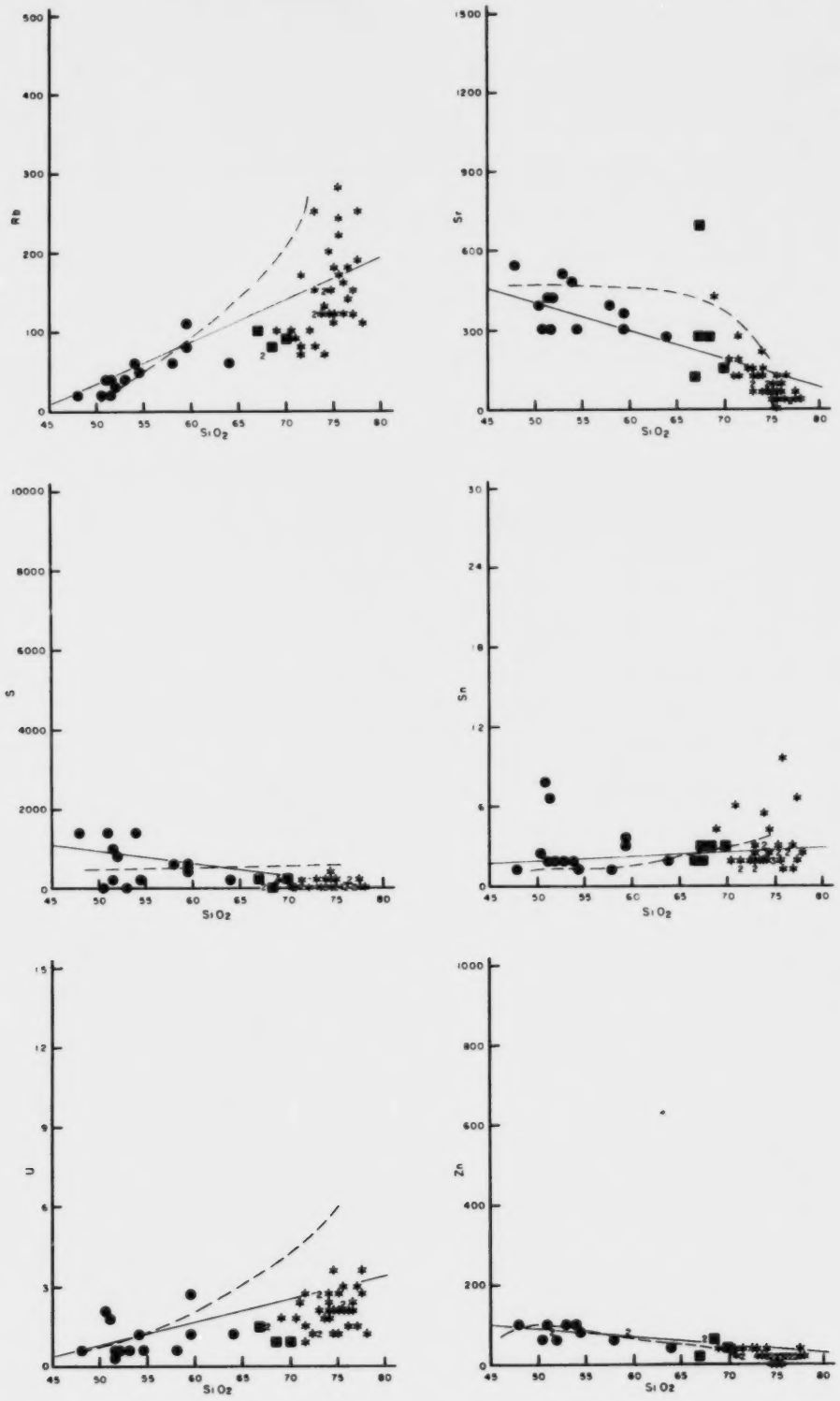


Figure 3-4. Continued.

Barium shows a resonable trend in the dioritic complex, increasing with increasing silica content. However Ba values are extremely varied in the leucogranite and associated phases, although average levels are similar to those in other plutons of the present study and those presented by Gribble (1969). The reason for the scatter is Ba values is not clear (see discussion in Chapter 11).

Copper values are low in all phases analyzed. They are somewhat higher in the rocks of the dioritic complex than in the leucogranite and generally decrease with increasing silica, typical behaviour for copper (Gribble, 1969).

Fluorine shows considerable scatter although values are similar to those in other plutons of this study. They do not show the typical calc-alkalic trend indicated by Gribble (1969).

Lead is uniformly low in all analyzed samples, with no significant difference between the dioritic complex and the leucogranite. The leucogranite contains lower Pb than reported by Gribble (1969) for typical calc-alkalic granitic rocks.

Molybdenum is also uniformly low in all analyzed samples, with no significant difference between the dioritic complex and the leucogranite. At such low concentrations, the observed scatter is probably less than the analytical uncertainty (Appendix B) and hence not significant.

Rubidium shows a good positive correlation with silica. However considerable scatter characterizes Rb values in the leucogranite and related phases, with values generally lower than shown by Gribble (1969) for similar SiO_2 contents.

Strontium shows a good negative correlation with silica, with much less scatter in the leucogranite than shown by Rb.

Sulphur contents are extremely low in the leucogranite and associated phases, and somewhat higher in the dioritic complex.

Tin values are low in all analyzed samples, although a few samples have somewhat higher Sn contents than average.

Uranium values are low in all samples, although somewhat higher in the more felsic phases, as would be expected.

Zinc contents tend to decrease with increasing silica. This pattern is typical of other plutons of this study and calc-alkalic rocks in general.

ECONOMIC GEOLOGY

Small occurrences of galena in limestones near Fader Point were reported by Kelley (1960). However, these rocks are much younger than the Kellys Mountain pluton and hence the mineralization presumably is unrelated to the pluton.

With the exception of minor pyrite observed in the more mafic phases of the dioritic complex, no mineralization is known to occur in the Kellys Mountain pluton.

AGE

On the basis of field relations, the Kellys Mountain pluton is pre-Carboniferous, but younger than the George River Group which it has intruded. Six whole-rock samples from the leucogranite dated by Cormier (1972) gave an isochron age of 553 ± 25 Ma with an ititial $^{87}Sr/^{86}Sr$ ratio of 0.699 ± 0.002 (Keppie and Smith, 1978).

SUMMARY

The Kellys Mountain pluton is Late Precambrian or early Cambrian in age. It intruded the Precambrian George River Group and a gneissic complex of uncertain age. The pluton has been intruded by abundant mafic dykes, and is overlain nonconformably by sedimentary rocks of Carboniferous age. The pluton consists of coarse grained leucogranite (grading to biotite granodiorite) and fine grained granite intrusive into an older dioritic complex which ranges from hornblende diorite to granite. These plutonic rocks show abundances and patterns of major and trace elements which are broadly similar to those in typical calc-alkalic rocks and other plutonic rocks of Cape Breton Island. No significantly anomalous features are apparent in the geochemical patterns of the pluton, which is not known to have significant mineralization associated with it.

CHAPTER 4
ST. ANNS MOUNTAIN PLUTON

INTRODUCTION

LOCATION AND ACCESS

St. Anns Mountain is located on the southeastern margin of the Cape Breton Highlands (Fig. 1-1). It rises steeply from St. Anns Harbour on the east and southeast, and somewhat more gradually from the North River on the west and the Cabot Trail on the northwest and north (Fig. 4-1). The broad, relatively flat top of the Mountain has a elevation of about 300 m.

Much of St. Anns Mountain is underlain intrusive rocks (Kelley, 1960), here referred to as the St. Anns Mountain pluton. These rocks are the focus of the present study.

Access to the study area is by streams from the roadways which virtually surround the Mountain (Fig. 4-1).

SIZE AND EXPOSURE

Plutonic rocks underlie approximately 25 km^2 in the study area. Numerous streams descending the flanks of the Mountain provide excellent exposures. However little outcrop occurs on the relatively flat summit area which is characterized by dense evergreen growth and abundant bogs.

PREVIOUS WORK

The St. Anns area was first mapped by Fletcher (1884) and remapped in more detail by Kelley (1960). Kelley showed two plutonic units within the study area; an older unit of intermediate composition, and a younger granitic phase which he assumed to be Devonian. No petrographic or geochemical studies of these rocks were done. The plutonic rocks were shown in contact with a volcanic unit consisting of rhyolite and basalt which was interpreted to be correlative with the Fisset Brook Formation as described by Kelley and MacKasey (1964). These igneous rocks are overlain by sedimentary rocks of the Horton and Windsor Groups.

Polymetallic occurrences (Pb, Zn, Cu, Ag) are known to be associated with quartz veins intruding the plutonic rocks as well as the volcanic unit (Assessment Files, Nova Scotia Department of Mines and Energy). Disseminated Cu-Mo occurrences are also known to be associated with granitoid rocks on Murray Brook (Ransom, 1966; Kirkham and Soregaroli, 1975).

GEOLOGICAL SETTING

The oldest plutonic rocks exposed in the study area consist of coarse grained hornblende granodiorite grading to quartz diorite (Fig. 4-1). They were intruded by other rocks of the St. Anns Mountain pluton, primarily leucogranite and associated phases.

These intrusive rocks are in contact with a steeply dipping volcanic unit consisting of pinkish green crystal tuffs, rhyolite, and basalt. Where exposed, these contacts are generally faulted, so the relative ages of the intrusive and volcanic rocks are inferred on the basis of the absence of contact metamorphism and leucogranite dykes in the volcanic rocks. However, adjacent to the contact on the shore of St. Anns Harbour the leucogranite is porphyritic and could be a chilled marginal phase of the pluton. Furthermore dykes of quartz diorite and granodiorite do occur in the volcanic rocks although these are interpeted to be younger intrusive events (Fig. 4-1). Hence the relative ages of the St. Anns pluton and the volcanic rocks are not really certain. Kelley and MacKasey (1964) correlated these volcanic rocks with the Upper Devonian Fisset Brook Formation present elsewhere in Cape Breton Island. In its type area (along Fisset Brook) this Formation consists of a sequence of volcanic rocks and interbedded red shales and conglomerates located at the base of the Horton Group. On St. Anns Mountain angular discordance occurs between the volcanic rocks and the overlying sedimentary rocks of the Horton Group. Furthermore the St. Anns volcanic unit lacks the interbedded clastic sedimentary rocks of the Fisset Brook Formation. These observations suggest that the St. Anns volcanic unit does not correlate with the Fisset Brook Formation and can be described only as pre-Carboniferous in age.

As mentioned above, dykes and pods of quartz diorite and granodiorite occur within the volcanic rocks. In addition, a swarm of fine grained mafic dykes has intruded both plutonic and volcanic rocks. These range in width from less than 1 m to 4 m and have varied orientations. Bodies of pink porphyritic quartz monzonite are the youngest igneous rocks in the study area, cutting even the mafic dykes.

Relatively flat-lying strata of both the Horton and Windsor Groups nonconformably overlie or are in fault contact with the older rocks. They consist of conglomerate, red sandstone, and shale (Horton Group); and limestone, calcareous shale, and sandstone (Windsor Group). The clastic rocks of the Horton Group are generally poorly indurated.

PLUTONIC ROCKS

FIELD RELATIONS

The oldest rocks exposed on St. Anns Mountain are coarse grained granodiorites gradational into quartz monzodiorite, quartz diorite, and tonalite. These occur in the northern part of St. Anns Mountain and extend to the north of the study area (Fig. 4-1). A large area in which these rocks are strongly altered was mappable in the north-central part of the pluton. The cause of this hydrothermal alteration is not clear.

The granodiorite and related rocks are intruded by coarse grained pink leucogranite gradational to biotite granite which is in places porphyritic. Associated with the leucogranite are pods and dykes of pink fine grained aplite and minor pegmatite. The latter forms small veins and vugs exposed on the shoreline of St. Anns Harbour. The leucogranite is the most abundant phase of the pluton and also extends to the north of the study area. Dykes of leucogranite

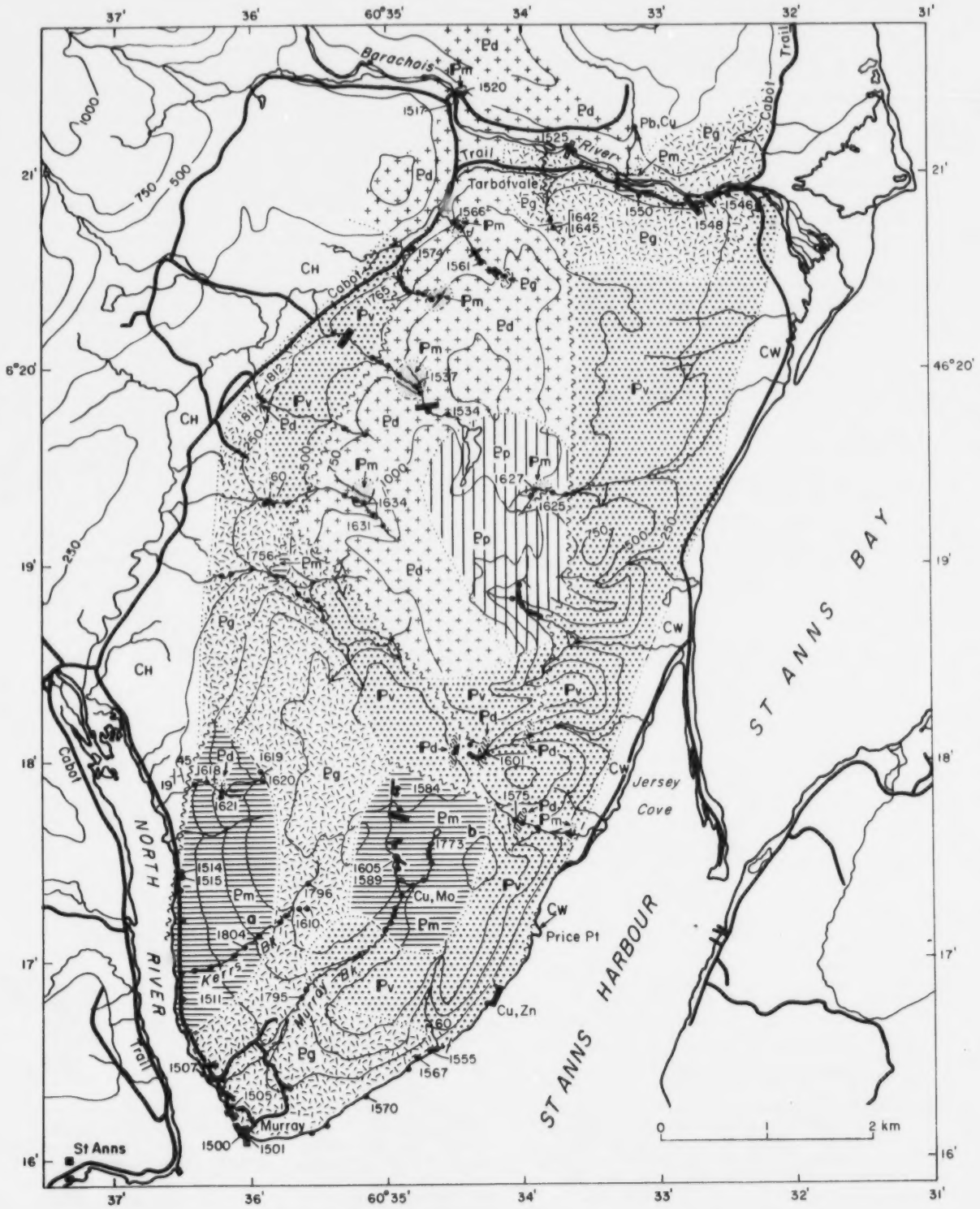


Figure 4-1. Geology of the St. Anns Mountain pluton. See Figure 1-1 for location of map area.

LEGEND

CARBONIFEROUS

WINDSOR GROUP

Cw — *Limestone, calcareous shale, sandstone*

HORTON GROUP

CH — *Conglomerate, red sandstone, shale*

PRE-CARBONIFEROUS

Pm — *Porphyritic quartz monzonite*

Mafic dyke

Pd — *Quartz diorite, granodiorite (dykes, pods)*

Pv — *Crystal tuffs, rhyolite, basaltic flows*

LATE PRECAMBRIAN-CAMBRIAN

Pg — *Biotite granite, leucogranite, minor aplite, porphyritic granite*

Pm — a. *Hornblende biotite granite* b. *Granodiorite*

Pp — *Altered granodiorite, quartz diorite*

Pd — *Hornblende granodiorite, quartz monzodiorite, quartz diorite, tonalite*

SYMBOLS

Geological boundary (defined, approximate, assumed) ——— - - - ·····

Fault (defined, approximate, assumed) ..... ~~~ ~~~ ~~~

Quartz veins .....

Bedding (inclined, vertical) .....

Sample location and analysis number ..... •← 1500

Mineral occurrence ..... Cu, Mo

Contour (feet) ..... ——250——

Some geological boundaries after Fletcher (1884), and Kelley (1960)

are abundant in the older granodiorite and related phases.

Coarse grained white to pale pink hornblende biotite granite and granodiorite occur in two areas within the leucogranite in the southern and eastern parts of the study area (Fig. 4-1). A few isolated outcrops are also present elsewhere. Gradational relationships exist between these rocks and the leucogranite. The granodiorite contains Cu-Mo mineralization in quartz veins and as disseminations in the upper part of Murray Brook.

Dykes and small pods of quartz diorite and granodiorite are common in the volcanic rocks whereas bodies of porphyritic quartz monzonite are dispersed through the hornblende granodiorite/quartz diorite. The porphyritic quartz monzonite is definitely younger than the mafic dykes, but the relationship between these bodies and the dykes and pods of quartz diorite/granodiorite is not known. Hence the age sequence displayed in the legend of Figure 4-1 is somewhat speculative.

PETROGRAPHY

Hornblende Granodiorite and Related Phases

In hand specimen the hornblende granodiorite and related phases are varied tones of white and grey in colour. Plagioclase (andesine) comprises 30 to 40 per cent of the rocks and is usually highly saussuritized. Perthitic orthoclase and quartz are present in variable amounts up to 20 per cent so the rocks range from quartz diorite through tonalite and quartz monzodiorite to granodiorite (Fig. 4-2a). The orthoclase is relatively unaltered and forms interstitial anhedra and mantles on subhedral plagioclase laths. Quartz is also interstitial. Fresh subhedral hornblende is generally poikilitic and comprises 20 to 50 per cent of the samples. Biotite is commonly present in association with the hornblende. Minor chlorite occurs as an alteration product of the mafic minerals. Sphene, apatite, and opaques are common accessory minerals.

In a large area in the central and eastern part of the pluton, alteration of these rocks is particularly intense. In places the original mineralogy has been completely obliterated to form essentially a quartz-sericite-chlorite rock. None of these highly altered samples was selected for analysis.

Hornblende Biotite Granite and Granodiorite

The hornblende biotite granite and granodiorite are distinguished in hand specimen from the leucogranite by whiter colour and the presence of fresh biotite, commonly accompanied by hornblende. They contain anhedral quartz (15% to 30%) and orthoclase (10% to 30%), and subhedral plagioclase (30% to 50%) and mafic minerals (10% to 20%). The plagioclase ranges in composition from An_{30} to An_{35} and is partially saussuritized. The orthoclase is somewhat perthitic. Biotite occurs as separate grains and as an alteration product of hornblende. Although similar in appearance, the two main areas of occurrence of this phase differ in modal composition (Fig. 4-2a). They are grouped as one unit because both have gradational relationships with the leucogranite.

Leucogranite and Related Phases

The leucogranite is coarse grained and pink in colour due to hematitic staining of feldspars. It consists primarily of anhedral quartz (25% to

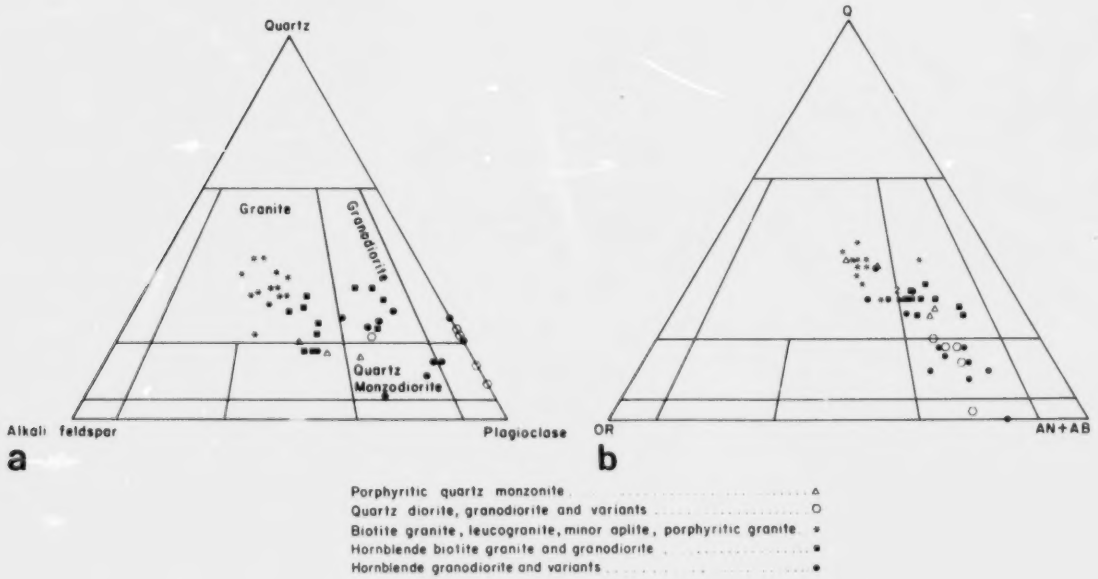


Figure 4-2. Modal mineralogy (a) and normative mineralogy (b) for St. Anns Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN +AB = normative anorthite plus albite.

40%), oligoclase (30% to 40%) and perthitic orthoclase (30% to 50%). The orthoclase is relatively unaltered, but the plagioclase is extensively saussuritized in many samples. Texture is hypidiomorphic granular. The main mafic mineral present is chlorite (<5%) which is probably secondary after biotite. With increasing amounts of chlorite and some relict biotite, the leucogranite grades into biotite granite. In places the leucogranite is porphyritic, with phenocrysts of quartz and plagioclase. Graphic intergrowths of quartz and feldspar are common in the groundmass.

The aplitic subphase has essentially the same mineralogy as the granite except for a virtual absence of mafic minerals. Texture is typically fine grained and granophyric. Associated pegmatites consist primarily of quartz and orthoclase.

Quartz Diorite and Granodiorite (Dykes and Pods)

The quartz diorite and granodiorite are medium- to coarse-grained and vary in colour from purple to pink. The quartz diorite consists of highly altered andesine (50% to 60%) and hornblende (20% to 30%). The hornblende is partially replaced by chlorite. Quartz occurs as small interstitial anhedral grains. The granodiorite contains more quartz and orthoclase, and more sphene and chlorite, representing former hornblende.

Porphyritic Quartz Monzonite

The porphyritic quartz monzonite is pink in colour. It consists of coarse grained subhedral to euhedral phenocrysts of plagioclase (An_{27-30}) and quartz in a medium grained matrix containing graphic intergrowths of quartz and feldspar. Chlorite (presumably secondary after biotite) occurs as large poikilitic phenocrysts and as small grains in the groundmass. Epidote is also present as small grains in the groundmass and as an alteration product of the plagioclase phenocrysts.

Aplites associated with the quartz monzonite bodies have typical aplitic mineralogy and graphic textures.

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies are presented in Appendix D. Average analyses and standard deviations for each of the five phases of the St. Anns Mountain pluton are presented in Table 4-1. Generally large standard deviations reflect petrographic heterogeneity within these groupings, which is better appreciated on the silica variation diagrams (Fig. 4-3). The trend lines derived from analytical data for other plutons in Cape Breton Island and Gribble (1969) as described in Chapter 1 are shown for comparison.

The **hornblende granodiorite and related phases** range from intermediate to mafic in composition, with major oxide contents similar to those in typical calc-alkalic plutonic rocks and the other plutons of this study, although TiO_2 contents are somewhat lower than average.

The **leucogranite** ranges from intermediate to felsic with the biotite-granite and porphyritic-granite subphases intermediate in composition and the aplitic subphase extremely felsic. They are chemically similar to rocks in other plutons with similar silica contents.

The **hornblende biotite granite and granodiorite** overlap in chemistry with the more intermediate subphases of the leucogranite with which they are gradational. However, they are distinctly lower in K_2O and higher in Na_2O than average (Fig. 4-3).

The pods of **quartz diorite and granodiorite** are somewhat less mafic than the older hornblende granodiorite and quartz diorite but show similar trends with varying SiO_2.

The **porphyritic quartz monzonite** is similar to the other intermediate rocks in major element geochemistry.

Within each phase and in the suite as a whole, TiO_2, Al_2O_3, Fe_2O_3T, MnO, MgO, CaO, and P_2O_5 display negative correlations with SiO_2 whereas K_2O displays positive correlation. Na_2O shows only a slight tendency to increase with increasing SiO_2.

Samples cluster more closely on the normative Q-Or-Ab+An plot (Fig 4-2b) than on the corresponding modal plot (Fig. 4-2a).

Trace Element Geochemistry

Average analyses and standard deviations for each of the five phases of the St. Anns Mountain pluton are presented in Table 4-1. The data are displayed on silica variation diagrams (Fig. 4-4). The trend lines shown on these diagrams are derived from the analytical data for unmineralized plutons and Gribble (1969) (as described in Chapter 1). The elements are discussed below in alphabetical sequence. Tungsten values are below the detection limit of 4 ppm and are not discussed.

Arsenic values are generally similar in all phases, a pattern typical of other plutons of this study. The higher than average levels may be the result of analytical error (Appendix B).

Barium shows wide scatter, especially in the felsic rocks. This pattern is also typical of other plutons of this study, and average levels are consistent with Gribble (1969).

Copper values are comparable to those in other plutonic rocks and show negative correlation with silica. Sample 1589 from the mineralized area of the granodiorite contains anomalously high Cu.

Fluorine contents tend to decrease slightly with increasing silica, although there is considerable scatter. Average levels are similar to those of Gribble (1969), although the trend is not.

Table 4-1. Average analyses and standard deviations for the five main phases in the St. Anns Mountain pluton.

	Granodiorite (n = 13)		Hornblende Biotite Granite and Granodiorite (n = 11)		Leucogranite (n = 13)		Quartz Diorite (n = 5)		Prophyritic Quartz Monzonite (n = 4)	
SiO_2	59.03	± 5.50	67.74	± 1.84	73.08	± 4.02	56.90	± 4.91	66.76	± 3.83
TiO_2	0.68	0.27	0.29	0.06	0.25	0.12	0.96	0.20	0.34	0.14
Al_2O_3	16.44	1.50	15.34	0.89	12.55	1.79	16.74	0.65	14.60	1.00
Fe_2O_3T	6.45	2.14	3.47	0.53	2.27	1.12	7.73	1.15	3.64	1.31
MnO	0.12	0.05	0.08	0.02	0.04	0.03	0.05	0.01	0.08	0.03
MgO	3.04	1.30	1.41	0.29	0.57	0.45	3.84	1.43	1.50	0.63
CaO	5.09	1.92	2.68	0.98	1.57	0.92	5.29	1.38	3.74	1.23
K_2O	2.84	0.70	2.87	0.65	4.11	0.73	2.54	0.36	3.29	0.65
Na_2O	3.32	1.09	3.87	0.38	3.48	0.35	3.43	0.46	3.11	0.29
P_2O_5	0.17	0.07	0.11	0.02	0.07	0.04	0.19	0.06	0.11	0.04
As	9	± 4	8	± 5	9	± 4	6	± 4	9	± 5
Ba	415	127	427	87	468	185	512	155	509	92
Cu	67	46	48	114	14	26	62	27	20	12
F	550	140	480	170	430	120	630	80	530	170
Pb	11	6	19	40	22	35	15	7	24	15
Mo	2	<1	2	<1	2	<1	2	<1	3	<1
Rb	84	27	74	19	141	29	87	7	95	22
Sr	395	170	277	55	132	117	456	63	348	80
S	80	70	90	90	50	40	180	160	150	230
Sn	2	<1	2	<1	4	2	2	<1	2	<1
U	2	<1	3	<1	3	<1	1	<1	2	<1
Zn	71	25	52	11	37	19	116	33	56	4

Lead values are very low and similar in all phases, with the exception of leucogranite sample 1515. No explanation is apparent from the petrography.

Molybdenum values are low and similar in all phases.

Rubidium levels are similar in the mafic and intermediate rocks and increase in the felsic phases. This pattern is also typical of other plutons, although values in felsic rocks are below the level shown by Gribble (1969).

Strontium shows a negative correlation with SiO_2, although St. Anns Mountain pluton tends to have higher Sr than average in mafic phases and lower Sr than average in felsic phases compared to other plutons.

Sulphur levels are low and similar in all phases, although somewhat higher and more variable in the later phases (quartz diorite/granodiorite and porphyritic quartz monzonite).

Tin shows weak positive correlation with SiO_2, being highest in the felsic rocks.

Uranium shows good positive correlation with SiO_2, although values are low in all phases.

Zinc shows negative correlation with SiO_2 and like Sn and U, the values are similar to those in other plutons of this study.

ECONOMIC GEOLOGY

Two types of mineralization occur on St. Anns Mountain (Ransom, 1966). Minor pyrite, chalcopyrite, and small amounts of molybdenite occur along fractures and disseminated in altered hornblende biotite granodiorite along Murray Brook (Fig. 4-1). This occurrence has been described as having some similarities to typical porphyry mineralization (Kirkham and Soregaroli, 1975). The other type of mineralization on St. Anns Mountain is polymetallic (Pb, Zn, Cu, Ag) showings associated with quartz-carbonate veins in volcanic rocks near Price Point. These veins have a consistent trend of 120° to 130°.

Hence the St. Anns Mountain pluton is included in this study as a mineralized pluton, although the mineralization is restricted in its distribution.

AGE

Field relations do not provide an indication of the age of the St. Anns Mountain pluton other than that it is pre-Carboniferous. Seven samples of leucogranite collected during the present study have yielded a Rb/Sr whole rock isochron age of 515 ± 17 Ma with an initial ratio of $^{87}Sr/^{86}Sr$ of 0.7055 ± 0.0073 (Cormier, 1980).

SUMMARY

The St. Anns Mountain pluton is a locally mineralized intrusion of Cambrian age. It is a composite body consisting of, from oldest to youngest, hornblende granodiorite (and related phases), hornblende biotite granite and granodiorite, and leucogranite (and related phases) intruded by younger dykes and minor bodies of pre-Carboniferous age and ranging in composition from mafic to felsic. Cu-Mo mineralization of porphyry (?) affinities is associated with the granodiorite body within the leucogranite whereas Cu-Zn-Pb-Ag mineralization occurs in younger quartz carbonate veins possibly associated with the later minor igneous phases.

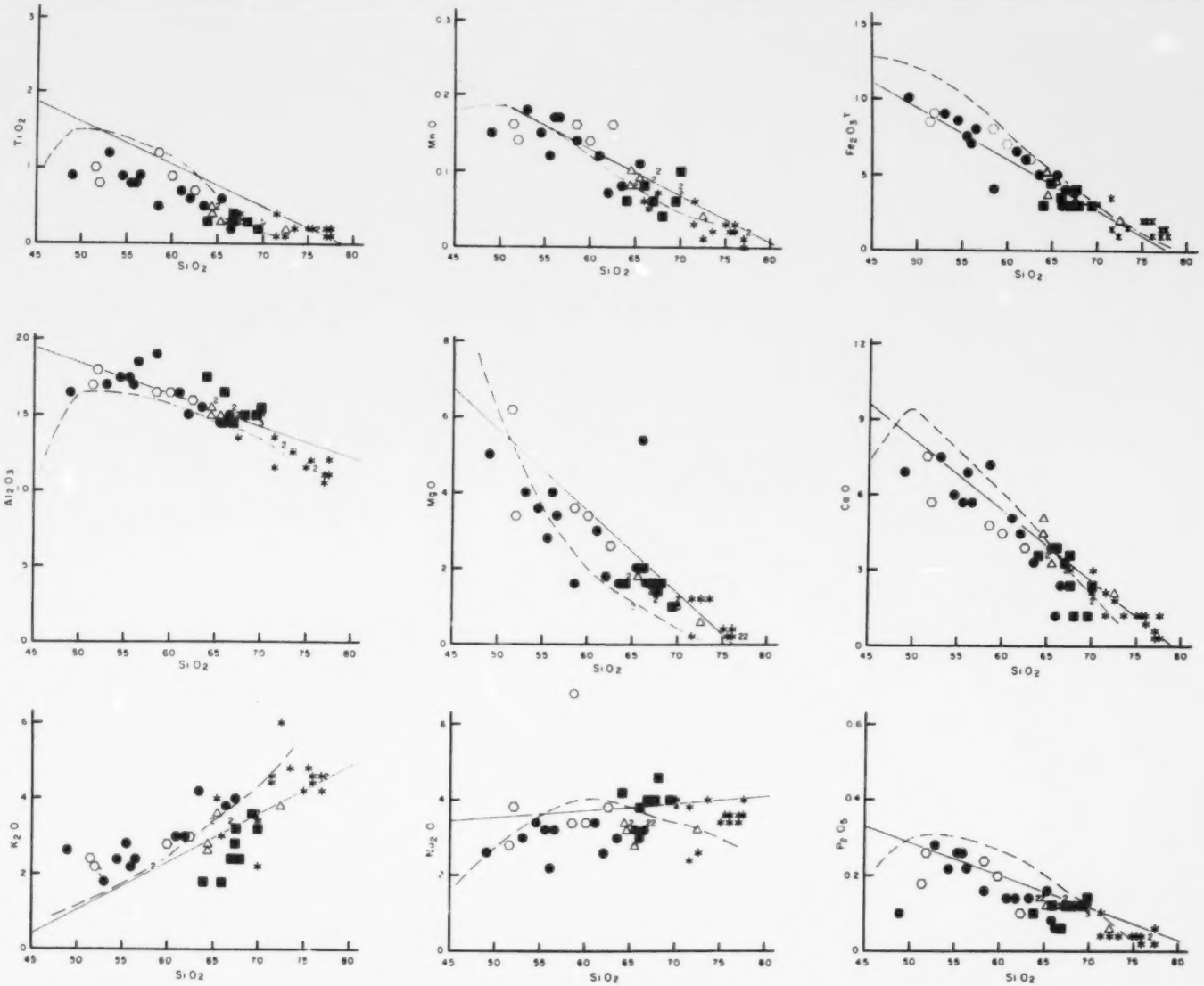


Figure 4-3. Silica variation diagrams for major element oxides in the St. Anns Mountain pluton. Symbols as in Figure 4-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

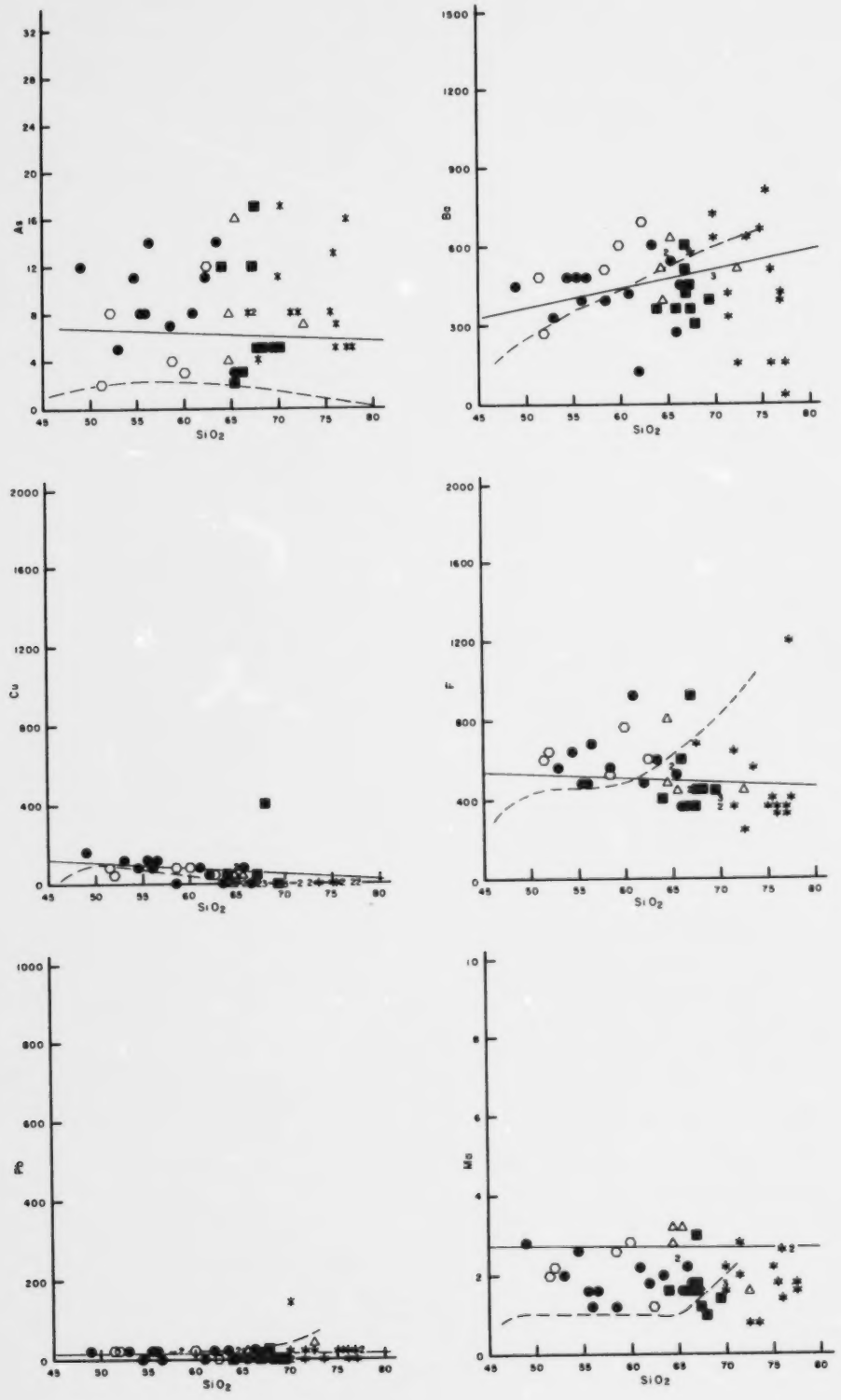


Figure 4-4. Silica variation diagrams for trace elements in the St. Anns Mountain pluton. Symbols and lines as in Figures 4-2 and 4-3, respectively.

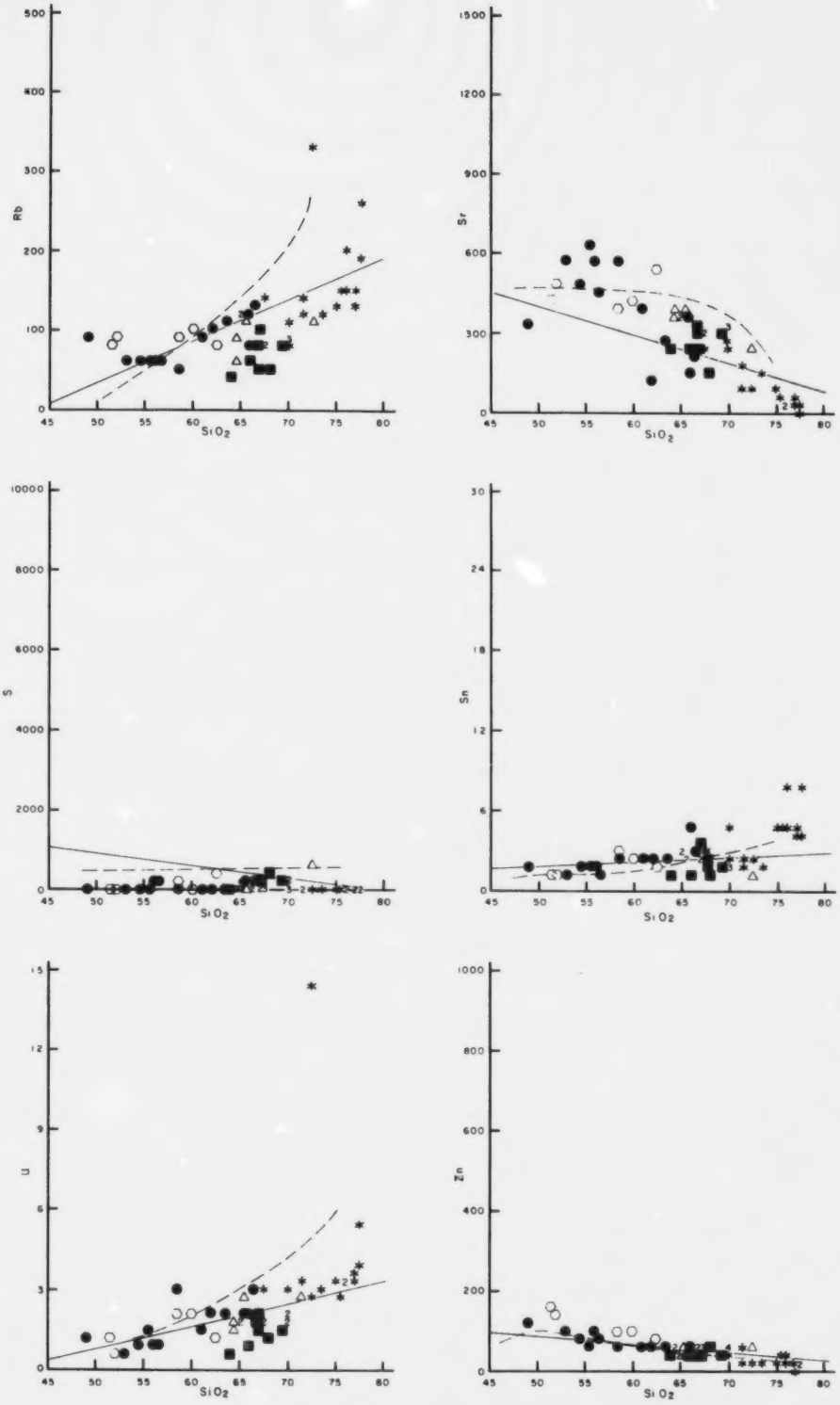


Figure 4-4. Continued.

CHAPTER 5
CAPE SMOKY PLUTON

INTRODUCTION

LOCATION AND ACCESS

The Cape Smoky pluton extends southwest from Cape Smoky across Smoky Mountain along the eastern shore of Cape Breton Island (Fig. 1-1). The southern limit of the study area was placed at Wreck Cove Brook (Fig. 5-1), although plutonic rocks extend farther to the south (MacLaren, 1956). The Ingonish River pluton (Wiebe, 1972) lies at the western edge of the study area (Unit Od, Fig. 5-1). Plutonic rocks of Middle Head north of South Bay Ingonish were also included in this study.

The area is mountainous, forming the eastern margin of the Cape Breton Highlands, and includes some of the most spectacular scenery of the Cabot Trail. Elevations exceed 400 m. The Cabot Trail crosses the study area, and streams accessible from this highway provide access to the interior of the pluton. The cliffs forming the shoreline from Pathend Brook to Ingonish Harbour are accessible only by boat.

SIZE AND EXPOSURE

The Cape Smoky pluton is approximately rectangular in shape, 14 km long with a maximum width of 5 km. In the northern part of the pluton good exposures occur along streams, coastal cliff faces, and roadcuts along the Cabot Trail. In the south no coastal exposure exists and accessible outcrops are generally in the streams which traverse the pluton and also along Wreck Cove Road.

PREVIOUS WORK

The area was previously mapped by MacLaren (1956) who showed the study area to be underlain predominantly by coarse grained biotite granite. He interpreted this to be older than the quartz diorite and granodiorite to the west. Wiebe (1972) mapped the northern part of the area and assigned the names Cape Smoky pluton and Ingonish River pluton to the two major rock bodies in the area. He interpreted the Cape Smoky pluton to be intrusive into the Ingonish River pluton. Wiebe also presented modal analyses and a few chemical analyses of samples from these plutons. Cormier (1972) determined an age of 453 ± 42 Ma (as recalculated by Keppie and Smith, 1978) for the Cape Smoky pluton based on a Rb/Sr isochron.

GEOLOGICAL SETTING

The oldest rocks in the study area are biotite-quartz-feldspar gneisses which occur in a few isolated outcrops near the headwaters of Wreck Cove Brook. They display a well developed foliation which is locally contorted. The gneisses are intruded by granodiorite and pink granite veinlets which are probably related to the Ingonish River and Cape Smoky plutons.

A dioritic complex is exposed along Wreck Cove Brook, Wreck Cove Road, Ferrys Brook and MacLeods Brook, as well as in small areas along Morrison Brook (Fig. 5-1). It is characterized by variability of phases and complex phase relationships similar to those in the dioritic complexes associated with the Kellys Mountain and Huntington Mountain plutons, and is interpreted to be an older plutonic complex which was intruded by the Ingonish River and Cape Smoky plutons. It consists of diorite, quartz diorite, and hornblendite intruded by diorite, granodiorite, granite, aplite and porphyritic microgranite, the latter five probably correlative with phases of the Ingonish River and Cape Smoky plutons. Samples of the latter rocks were collected along Wreck Cove Road for analysis, but rocks of the older dioritic complex were not included in the analytical work of this investigation. Locally outcrops within the dioritic complex exhibit a tectonic foliation trending 040°. This foliation also occurs in the Cape Smoky pluton, commonly in the southwestern part of the study area and locally elsewhere.

Contacts of this dioritic complex with the biotite-quartz-feldspar gneiss are not exposed in the study area, but the gneiss is assumed to be older. Contacts between the dioritic complex and the main body of the Ingonish River pluton are also not exposed. The contact between the dioritic complex and the granite of the Cape Smoky pluton is exposed in Ferrys Brook and MacLeods Brook. Near the contact xenoliths of the dioritic complex are common in the granite, and the granite is chilled.

Abundant dark fine- to medium-grained mafic dykes occur in all phases of the Cape Smoky pluton. They consist of plagioclase, pyroxene, and minor hornblende in subophitic to ophitic texture. They are commonly 1 to 3 m in width, but a few are up to 10 m wide.

Red clastic sedimentary rocks of the Lower Carboniferous Horton Group nonconformably overlie the Cape Smoky pluton and older rocks. Close to contacts with the Carboniferous rocks the plutonic rocks are intensely weathered resulting in a crumbly texture and red colour. Evaporites of the Carboniferous Windsor Group are exposed west of Middle Head (MacLaren, 1956).

PLUTONIC ROCKS

FIELD RELATIONS

The Cape Smoky pluton is the focus of the present study. However it appears probable that the Ingonish River pluton of Wiebe (1972) is similar in age to the Cape Smoky pluton and that the two bodies are different phases of the same intrusive episode. Hence mapping, sampling, and petrographic and geochemical studies included parts of the Ingonish River pluton adjacent to the Cape Smoky pluton (Fig. 5-1). Within the mapped areas, the Ingonish River pluton varies gradationally from diorite through quartz diorite, tonalite, quartz monzodiorite, and granodiorite. Quartz diorite is most abundant. For example on Middle Head coarse grained diorite grades over a few metres into fine- to medium-grained diorite of similar mineralogy. Both are intruded by a more leucocratic granodiorite.

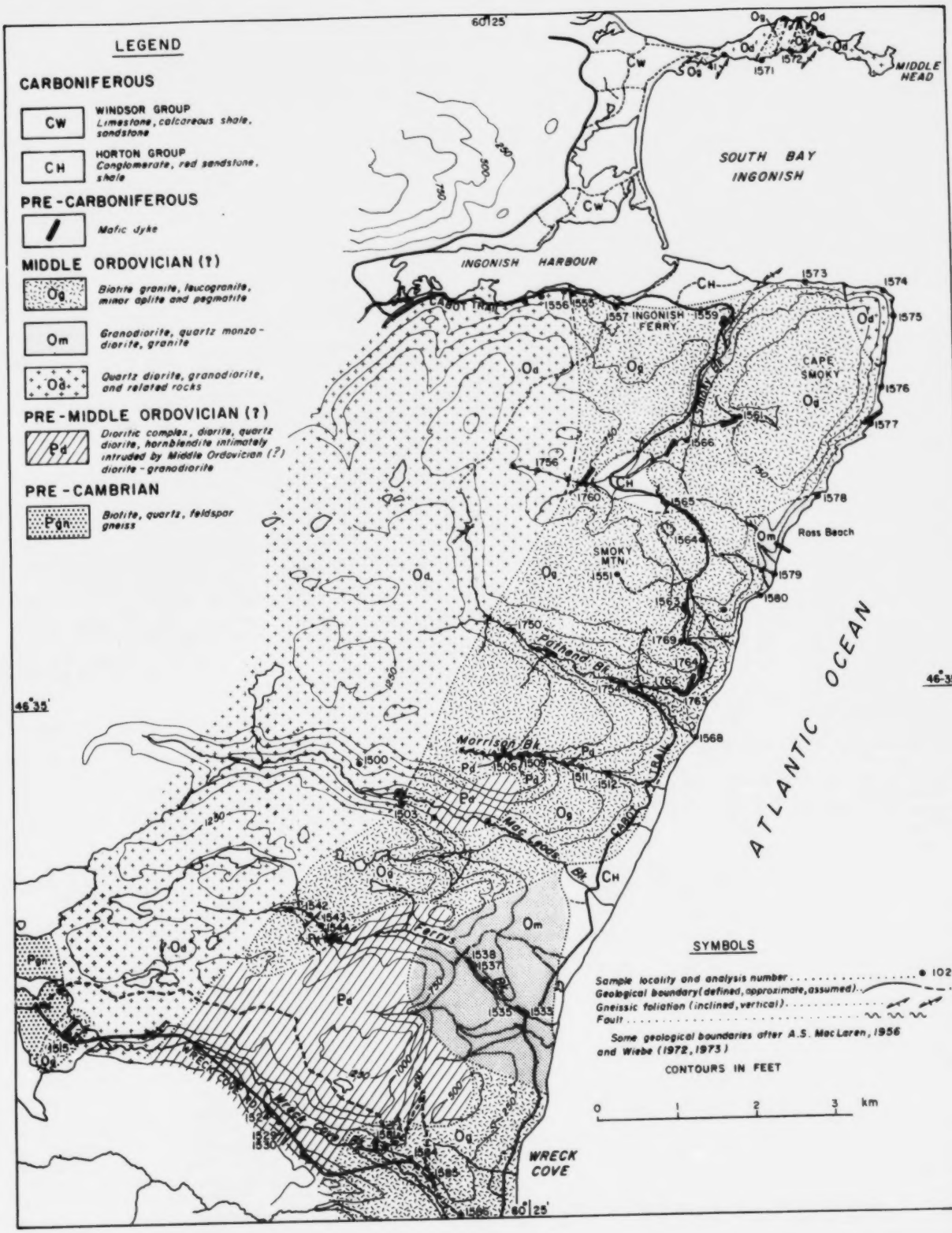


Figure 5-1. Geology of the Cape Smoky pluton. See Figure 1-1 for location of map area.

The Cape Smoky pluton consists predominantly of pink coarse grained biotite granite which is gradational to quartz monzonite and leucogranite. Small aplite dykes and pods are common throughout the study area. Small pegmatitic patches are most abundant in the shore section between Cape Smoky and Pathend Brook. Some pegmatite pods have an outer zone of aplite which grades into typical biotite granite.

Two areas of granodiorite (gradational to quartz monzodiorite and granite) are also present, one centred on Ferrys Brook and the other at Ross Beach (Fig. 5-1).

Contacts between the quartz diorite of the Ingonish River pluton and the biotite granite of the Cape Smoky pluton are exposed along the northern and southern shores of Middle Head where they are sharp with chilled margins up to 6 cm in width in the biotite granite. The contacts dip at angles less than 40°, with the granite on the upper side. Dykes and veins of granite and aplite are common in the quartz diorite. At Cape Smoky and west of Ingonish Ferry (Fig. 5-1) the contacts are characterized by zones of parallel granite dykes in the quartz diorite. The dioritic body at the tip of Cape Smoky has a bowl-like shape. West of Ingonish Ferry the contact zone is not well exposed but seems to be steeply dipping.

At Ross Beach contacts between the granodiorite and the biotite granite also consist of zones of parallel granite dykes. Contacts of the other granodiorite body in the vicinity of Ferrys Brook are not exposed.

The granodiorite phase of the Cape Smoky pluton is not exposed in contact with the Ingonish River pluton. However, gradational inhomogeneities in composition exist within both bodies resulting in considerable overlap in petrography between them. Hence they may be essentially contemporaneous, both being older than the biotite granite, but younger than the older dioritic complex.

Large dykes 3 and 7 m in thickness of pink porphyritic microgranite have intruded the granodiorite near Ferrys Brook and the biotite granite near the mouth of Pathend Brook.

PETROGRAPHY

Quartz Diorite and Related Phases (Ingonish River Pluton)

These rocks consist predominantly of plagioclase (Fig. 5-2a) and fresh poikilitic hornblende in subophitic texture. The plagioclase is of andesine composition. Small anhedral quartz grains comprise 0 to 10 per cent in the diorite/quartz diorite. The monzodiorite and granodiorite are characterized by the presence of microcline (<15%). Minor amounts of subhedral biotite coexist with hornblende. Sphene is a relatively abundant accessory in all variants, comprising up to 5 per cent of some samples. Apatite is also common. Minor chlorite is present as an alteration product of the mafic minerals.

Granodiorite

These rocks are grey in hand specimen with prominent subhedral biotite grains. They consist of quartz, plagioclase, microcline, biotite and hornblende in granular texture with accessory apatite, zircon, and opaques. The quartz forms large anhedral grains. Perthitic microcline occurs as small interstitial grains and as less common poikilitic phenocrysts. Plagioclase is generally zoned and partially saussuritized.

Deformational features are present in all samples, and include sutured boundaries and undulatory extinction in quartz, bent polysynthetic twins in plagioclase, and bent cleavage traces in biotite.

Biotite Granite

The biotite granite consists of anhedral quartz (20% to 40%), plagioclase (20% to 40%), perthitic microcline (20% to 40%) and biotite (5% to 15%). In hand specimen both plagioclase and microcline are pink in colour due to hematitic staining whereas quartz is milky white, giving the rock a pseudo-porphyritic appearance. In thin section the microcline appears unaltered whereas plagioclase varies from unaltered to partially saussuritized. Biotite shows minor alteration to chlorite. Texture is hypidiomorphic granular. Evidence of deformation includes undulatory extinction and subgrain development in quartz, bent polysynthetic twins in plagioclase, and bent cleavage in biotite.

With increasing biotite and plagioclase contents the biotite granite grades to quartz monzonite. Decreasing biotite content results in a leucogranite (Fig. 5-2a).

Aplite, Pegmatite, and Porphyritic Microgranite

Aplitic dykes and pods are pink and fine grained. They consist of quartz and feldspar in granophyric texture, with few or no mafic minerals.

Pegmatites consist of coarse intergrowths of quartz and alkali feldspar with few or no mafic minerals.

Porphyritic microgranite dykes in the granodiorite and biotite granite consist of phenocrysts of subhedral quartz, altered palgioclase, and chlorite (after biotite?) in a medium grained groundmass of subhedral plagioclase and interstitial quartz-alkali feldspar intergrowths.

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies are presented in Appendix D. Average analyses and standard deviations for each plutonic phase are listed in Table 5-1. The data are displayed on silica variation diagrams (Fig. 5-3) together with linear regression lines derived from the plutons of this study and Gribble (1969) (see Chapter 1).

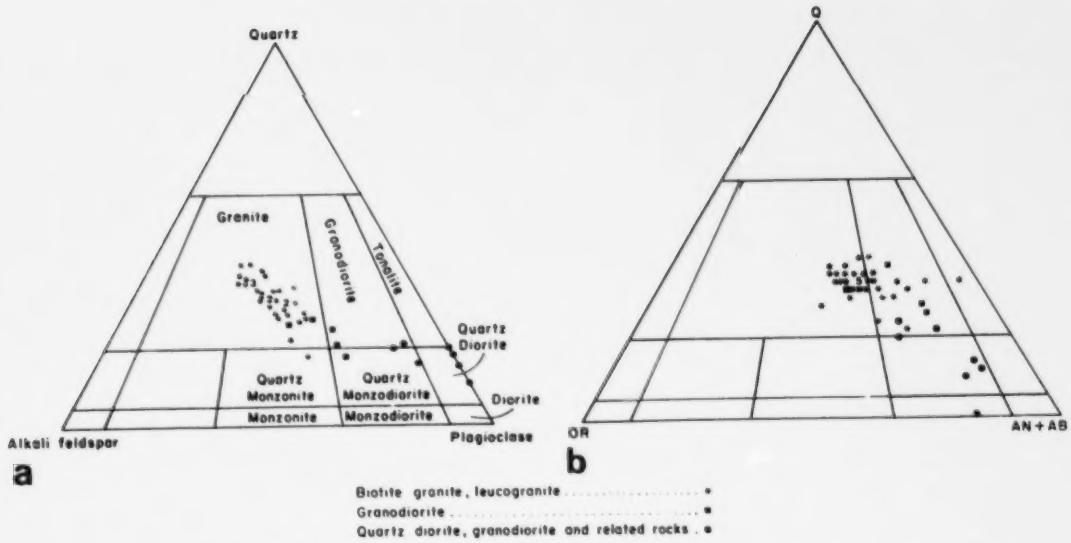


Figure 5-2. Modal mineralogy (a) and normative mineralogy (b) for Cape Smoky pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite.

The **quartz diorite and related rocks** show considerable spread in chemical composition, compatible with the petrographic range in analyzed samples from diorite to granodiorite. In terms of silica contents they range from mafic to intermediate (Table 5-1 and Fig. 5-3). Most oxides show reasonable correlation with SiO_2 although some samples may lie away from the trend (e.g. MgO). Only K_2O does not show any correlation with SiO_2. These rocks are lower in TiO_2 and Na_2O than rocks of similar SiO_2 contents from other Cape Breton plutons (see Chapter 11 for discussion).

The **granodiorite** ranges from intermediate to felsic, again consistent with the petrography of analyzed samples. No anomalous features are apparent in the major element chemistry.

The **biotite granite** is felsic, but shows some range in SiO_2 reflecting gradations from quartz monzonite to leucogranite. Compared to the quartz diorite and variants the biotite granite is low in Al_2O_3, TiO_3, Fe_2O_3T, MnO, MgO, CaO, and P_2O_5. The analyzed samples are remarkably similar in their contents of these oxides (Table 5-1). Na_2O and K_2O are more scattered with both generally higher than the quartz diorite/monzodiorite.

The samples as a group generally show typical calc-alkalic trends on the silica variation diagrams (Fig. 5-3). Al_2O_3, TiO_2, Fe_2O_3, MnO, MgO, CaO, and P_2O_5 show negative correlation with SiO_2 whereas K_2O shows positive correlation. Na_2O shows a poor positive correlation being generally higher although variable in the biotite granite.

Normative mineralogies are generally similar to modal mineralogies in terms of Q-Or-Ab+An (Fig. 5-2b). Although a few samples contain more than 1% normative corundum (Appendix D), as a whole the pluton is not peraluminous.

Trace Element Geochemistry

Trace element data for the Cape Smoky pluton and associated plutonic rocks are summarized in Table 5-1. The data for all analyzed samples are displayed on silica variation diagrams (Fig. 5-4). Trends and levels are generally consistent with those in other Cape Breton plutons and with those suggested by Gribble (1969) for calc-alkalic magma series. The main features are discussed below.

Arsenic values range from 1 to 16 ppm, with most between 2 and 8 ppm. They show no correlation with SiO_2, and are similar in all rock types. The values are similar to those in other plutons of the present study, and higher than those of Gribble (1969), perhaps due to analytical error (see Appendix B).

Barium tends to increase with increasing SiO_2, although the felsic samples show a very broad range of Ba values. The pattern is the same as in other plutons of this study and the average trend is similar to that presented by Gribble (1969).

Copper values range from a high of 79 ppm in the quartz diorite to a low of 1 ppm in the biotite granite. They show a negative correlation with SiO_2, typical of calc-alkalic rocks.

Fluorine values are uniformly low and show no trend with increasing SiO_2. They do not show the increase in felsic phases apparently typical of calc-alkalic rocks.

Lead values are extremely low in all analyzed samples, ranging from 2-16 ppm, and show no correlation with SiO_2.

Molybdenum values are generally low (about 2 ppm) and show no correlation with SiO_2. One sam-

Table 5-1. Average analyses and standard deviations for the three main phases in the Cape Smoky pluton.

	Quartz Diorite and Variants (n = 7)		Granodiorite (n = 5)		Biotite Granite (n = 34)	
SiO_2	55.91 ±	4.80	67.78 ±	3.84	72.80 ±	2.18
TiO_2	0.86	0.19	0.44	0.21	0.21	0.09
Al_2O_3	17.16	1.71	15.53	1.52	13.95	1.08
Fe_2O_3T	7.40	1.45	3.57	1.40	2.02	0.82
MnO	0.14	0.03	0.07	0.04	0.03	0.02
MgO	4.83	1.43	1.57	0.66	0.69	0.32
CaO	7.04	1.57	2.74	1.16	2.00	0.70
K_2O	1.97	0.69	2.96	1.03	3.76	0.99
Na_2O	2.72	0.40	3.70	0.60	3.77	0.57
P_2O_5	0.20	0.11	0.14	0.05	0.07	0.03
As	7 ±	5	8 ±	4	6 ±	3
Ba	280	102	599	150	618	303
Cu	43	33	15	10	6	6
F	450	90	460	90	370	80
Pb	4	3	2	<1	7	4
Mo	2	<1	3	3	2	<1
Rb	55	21	78	19	104	36
Sr	433	86	343	114	222	135
S	1180	1570	220	190	50	60
Sn	2	<1	2	<1	1	<1
U	1	<1	1	<1	2	<1
Zn	67	15	48	22	32	9

ple of granodiorite gave a value of 8 ppm for no apparent petrographic reason.

Rubidium shows a positive correlation with SiO_2. The biotite granite has considerable range in Rb content and values are lower than in average calc-alkalic granites.

Strontium shows a negative correlation with SiO_2, although the biotite granite has a considerable range and Sr levels in a few samples are as high as those in the more mafic phases.

Sulphur values are low except in three dioritic samples, which probably contain minor pyrite.

Tin values are low in all analyzed samples, ranging from 1-3 ppm.

Uranium values are low, but show a positive correlation with SiO_2.

Zinc values are at normal levels of about 30-70 ppm and show a typical negative correlation with SiO_2.

ECONOMIC GEOLOGY

No mineral occurrences are known to be associated with the Cape Smoky pluton. Disseminated pyrite was observed in the mafic dykes cutting the pluton.

AGE

On the basis of field relations, the Cape Smoky pluton is pre-Carboniferous. Cormier (1972) reported a Rb/Sr isochron age of 453 ± 42 Ma (Keppie and Smith, 1978) based on 5 samples from the biotite granite obtained from roadcuts on the Cabot Trail 6.4 km south of Cape Smoky. As this age was apparently unique among granitoid rocks of Cape Breton Island, the pluton was again sampled for dating during the present study to check the earlier data. However, an essentially identical isochron age of 447 ± 37 Ma was obtained for 11 samples from the biotite granite (Cormier, 1980). Although the significance of this age is uncertain (J. D. Keppie, personal communication, 1979), lack of alternative evidence necessitates recognition of the fact that this may be the true age of the pluton. Hence the Cape Smoky pluton is referred to in this report as Ordovician.

SUMMARY

The Cape Smoky pluton consists predominantly of biotite granite grading to leucogranite with smaller bodies of granodiorite and associated minor aplite and pegmatite. An older body of diorite/granodiorite (Ingonish River pluton) lies to the west. Both have intruded an older dioritic complex and quartz-feldspar-biotite gneiss, and are overlain nonconformably by clastic sedimentary rocks and evaporites of the Carboniferous Horton and Windsor Groups. An age of 447 ± 37 Ma obtained from a Rb/Sr isochron infers an Ordovician-Silurian age for the Cape Smoky pluton.

The plutonic rocks range from mafic to felsic and show abundances and patterns of major and trace element geochemistry which are broadly similar to typical trends in calc-alkalic rocks and to other plutonic rocks in Cape Breton Island. No anomalous features are apparent in the geochemistry of the pluton, which is not known to have significant mineralization associated with it.

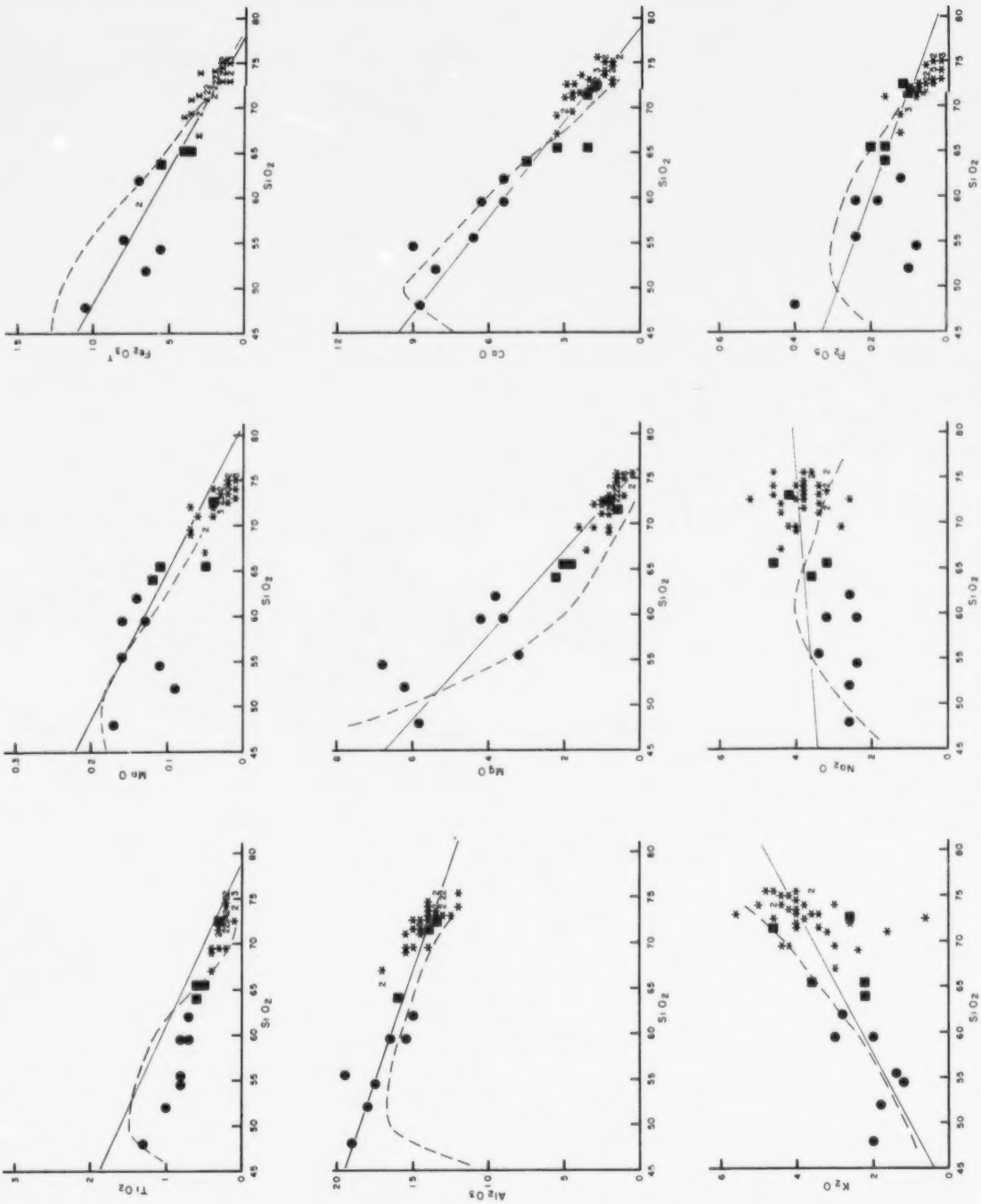


Figure 5-3. Silica variation diagrams for major element oxides in the Cape Smoky pluton. Symbols as in Figure 5-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

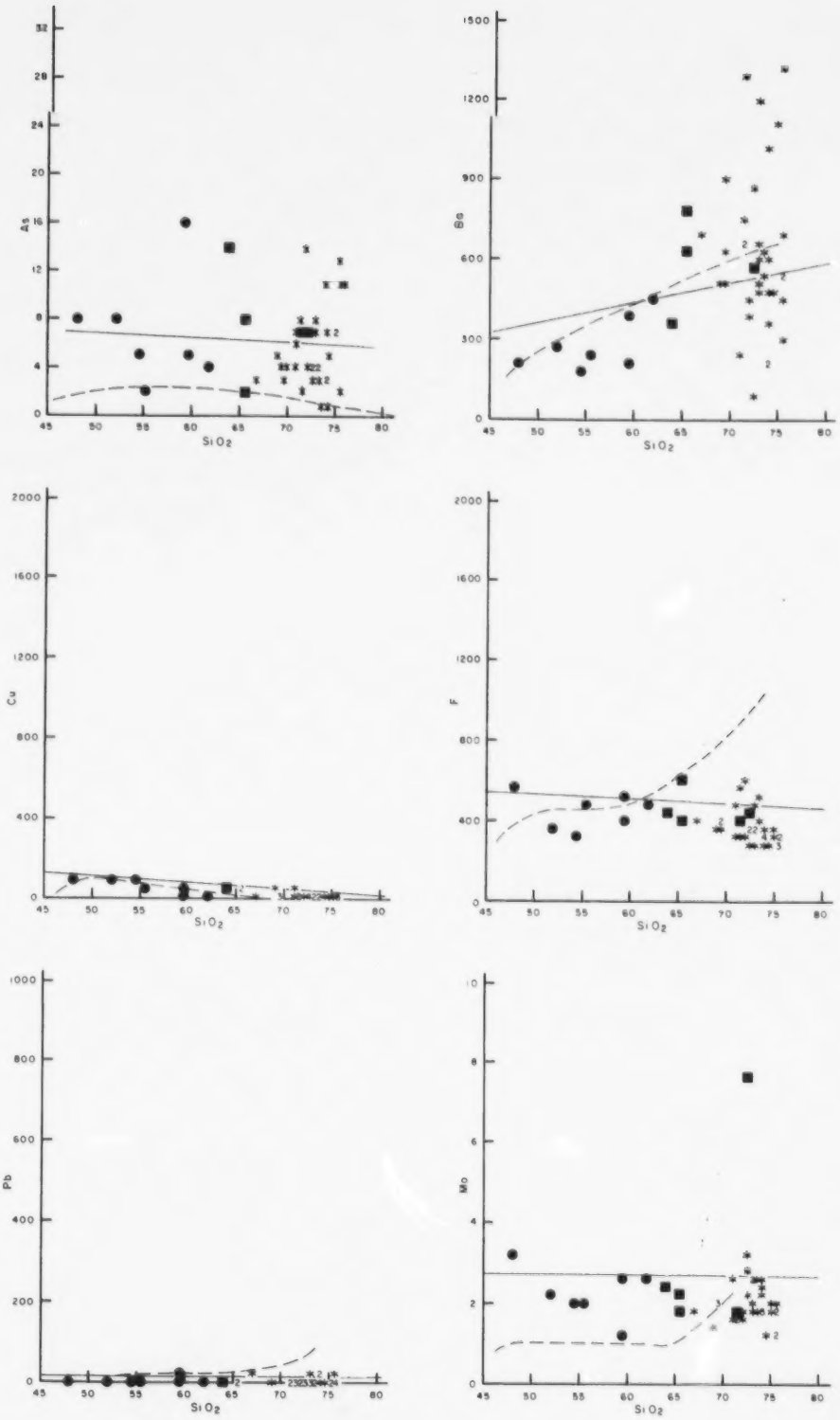


Figure 5-4. Silica variation diagrams for trace elements in the Cape Smoky pluton. Symbols and lines as in Figures 5-2 and 5-3, respectively.

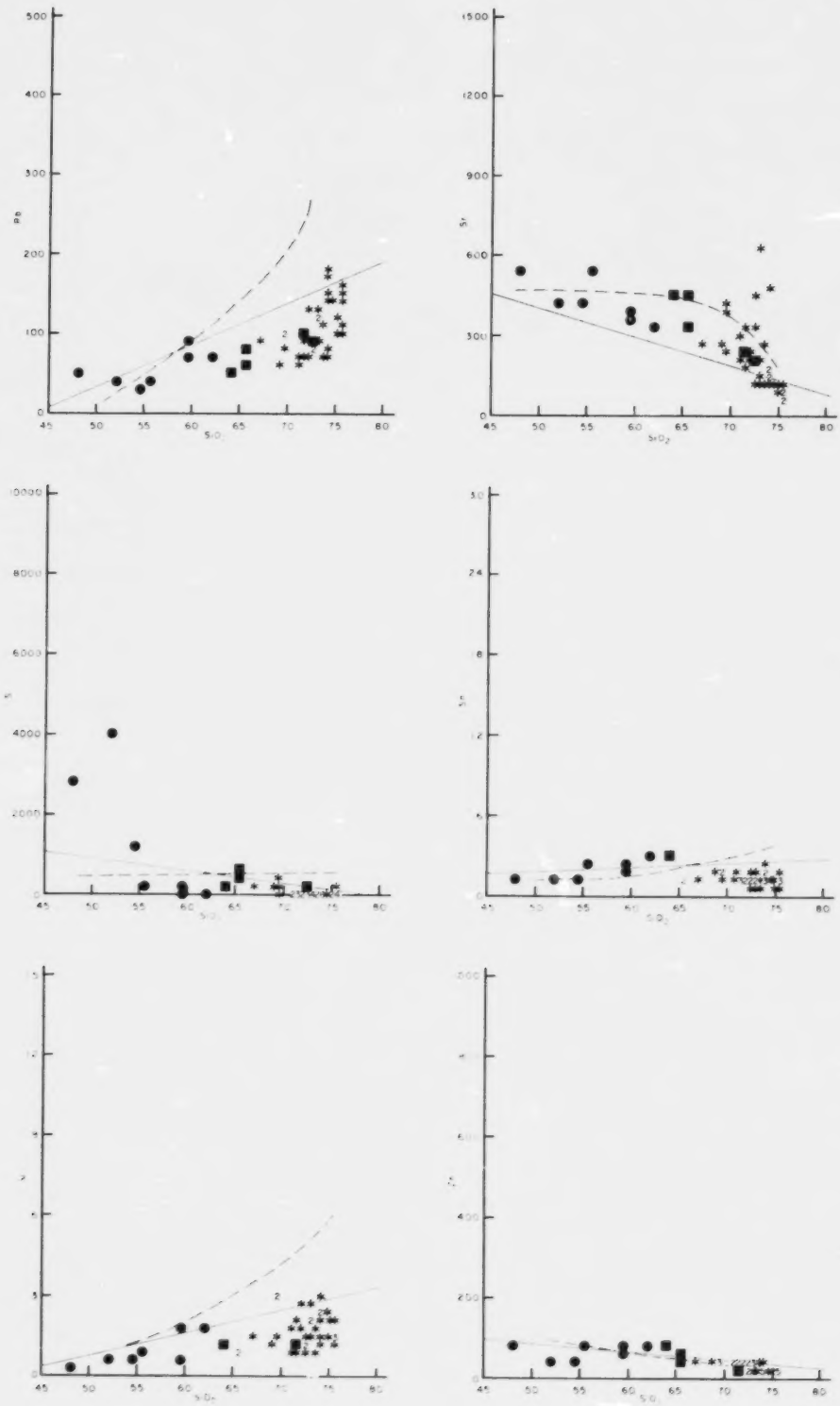


Figure 5-4. Continued.

CHAPTER 6
WHITE POINT PLUTON

INTRODUCTION

LOCATION AND ACCESS

The White Point pluton is a lobe of granitoid rock extending from the vicinity of the Cabot Trail north to the White Point area in northeastern Cape Breton Island (Figs. 1-1, 6-1). It is continuous with the Black Brook pluton to the south (Wiebe, 1975). For the purpose of this study the boundary between the two plutons was placed at Rachel Brook which served as the southern limit of the study area.

The terrane is relatively flat and gently sloping towards the coast from the uplifted peneplain of the Cape Breton Highlands. Topographic relief is related mainly to the larger streams, Smelt Brook, Trout Brook, and Rachel Brook. The Cabot Trail and White Point roads provide the only vehicle access to the area. Traverses were run by foot from these roads, along stream sections, and along the coastline.

SIZE AND EXPOSURE

The White Point pluton is approximately 30 km^2 in area. In addition to the main body of the pluton, dykes of granitoid rock are very abundant in adjacent older rock units, in places comprising 50 per cent or more of the outcrop.

The area is densely wooded with scrub spruce and brush. Rock exposure is generally poor except for major stream and coastal sections. Other outcrops are small and scattered.

PREVIOUS WORK

The area was originally mapped by Neale (1963) who showed large areas of pale red leucocratic granite in which quartz veins and coarse granite pegmatite were described as common. The granite intruded quartz-feldspar schists and gneisses which were correlated with the George River Group. Large areas of the country rock were interpreted to be hybrid rocks produced by granitic intrusion and/or replacement of these schists and gneisses.

Additional mapping in the area was done by Wiebe and co-workers in 1969 to 1971. As a result, Wiebe (1972, 1975) subdivided the "hybrid rocks" of Neale (1963) into two groups. Those to the west and south of the granite, consisting of marble, calc-silicate rocks, quartzite, metapelitic rocks, and metavolcanics, were correlated with either the George River Group or the Fourchu Group. Those to the east of the granite were termed the coastal gneisses and described as heterogeneous gneissic plutonic rocks ranging from hornblende diorite to granodiorite with microcline megacrysts, with minor metasedimentary and possibly metavolcanic layers or inclusions. On the basis of an apparent whole-rock Rb/Sr age of 560 Ma (Cormier, 1972; Keppie and Smith, 1978) Wiebe believed these foliated igneous rocks to be Precambrian. Wiebe (1972, 1975) also described the younger leucocratic granite in some detail, subdividing the main body into (from south to north) the Warren Brook, Black Brook, and White Point plutons. These were described as consisting of even-grained leucocratic granodiorite and adamellite (or granite, after Streckeisen, 1976). Chemical analyses showed a narrow compositional range, although K/Rb and Ca/Sr show some areal variation, and there is scatter in the content of alkalies.

Cormier (1972) analyzed ten whole-rock samples and two potassic feldspars from these granite bodies and obtained an isochron age of 403 ± 22 Ma (Keppie and Smith, 1978). Samples of whole-rock and muscovite from three pegmatite dykes associated with the White Point pluton were also analyzed and yielded an isochron age of 365 ± 12 Ma (Cormier, 1972; Keppie and Smith, 1978).

GEOLOGICAL SETTING

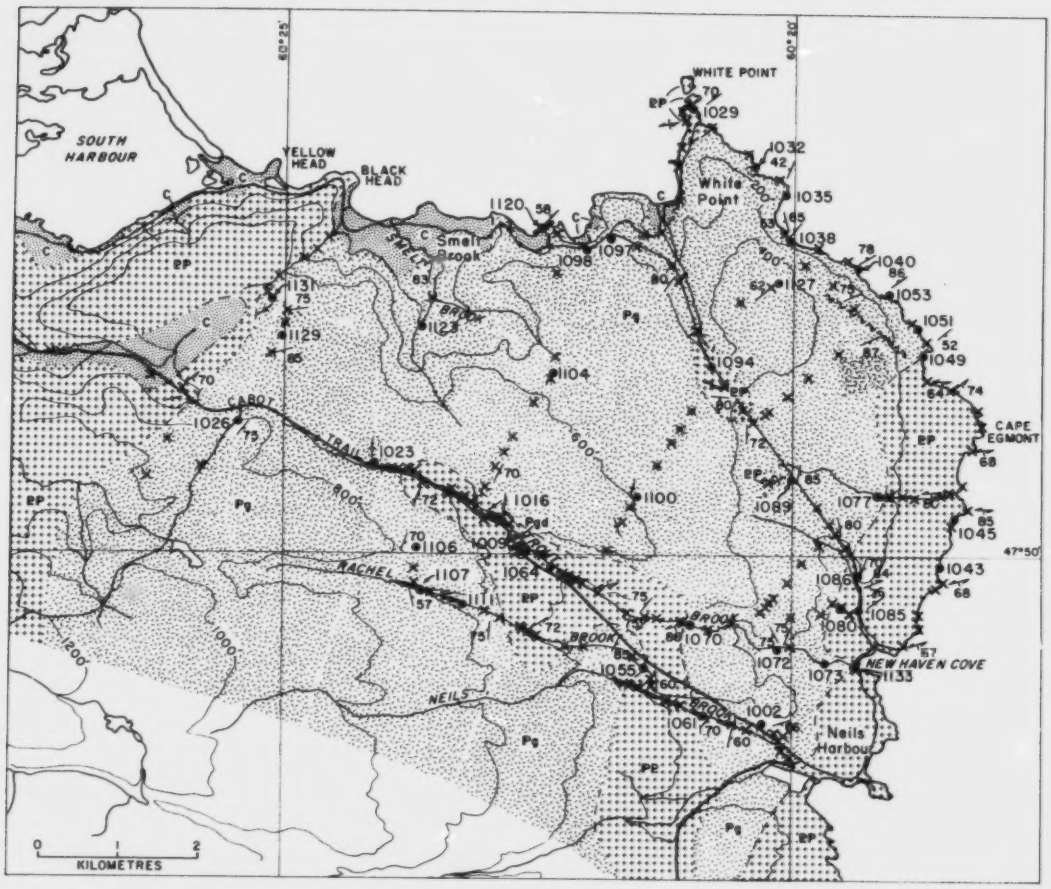
The White Point pluton intruded a heterogeneous metamorphic terrane which was divided by Wiebe (1972, 1975) into the coastal gneisses on the east and a heterogeneous assemblage of metamorphic rocks on the west which were correlated with the George River or Fourchu Groups, as described in the previous work. During the present study the metamorphic rocks both east and west of the White Point pluton are grouped as one unit because field evidence did not appear to warrant their subdivision, perhaps because extensive mapping was not done on the western side of the pluton.

The metamorphic rocks are beautifully exposed in the coastal section from Neils Harbour to the granite contact beyond Cape Egmont (Fig. 6-1). They consist of a mixture of gneiss and gneissic granodiorite/diorite. Commonly the gneissic granodiorite/diorite appears to occur as conformable intrusions into gneiss whereas in other areas the granodiorite/diorite dominates and the gneiss occurs as xenoliths and bands. In places the gneissic granodiorite/diorite is highly porphyroblastic with megacrysts (augen?) of microcline. Bands of biotite-rich amphibolite and schist occur sporadically. These metamorphic rocks are cut by numerous dykes of granodiorite, granite, pegmatite, and aplite related to the White Point pluton.

Within the White Point pluton itself, xenolith of gneissic granodiorite/diorite are numerous. In some areas these are porphyroblastic. Bands of gneiss and amphibolite occur more rarely. Due to poor exposure, the dimensions of these foliated bodies were generally difficult to determine, and the distinction between country rocks intruded by granitic dykes and granite with gneissose xenoliths is in places subjective, especially near the margins of the pluton.

Contacts between the granitic rocks and the gneissic rocks are always sharp. No chilling is apparent.

The granitic and older rocks are overlain by clastic sedimentary rocks of the Horton and/or Windsor Groups. The contacts are exposed at several localities along the shoreline between White Point and Smelt Brook, and in Smelt Brook and other stream sections nearby. In places they are



LEGEND

CARBONIFEROUS

C — *Horton and Windsor Groups*

PRE - CARBONIFEROUS (?)

Mafic dyke

DEVONIAN OR EARLIER

Pg — *Muscovite - biotite granite, biotite granite, muscovite granite, biotite granodiorite, pegmatite, aplite*

Granodiorite

CAMBRIAN OR EARLIER

EP — *Hornblende - biotite gneiss, porphyroblastic biotite gneiss, minor amphibolite and schist, cut by numerous dykes of (Pg)*

Sampled outcrop ..... ×

Outcrop sampled for chemical analysis ..... 1072●

Geological boundary (defined, approximate, assumed) .....

Gneissic foliation (inclined, vertical) .....

Flow (?) foliation in intrusive rock (inclined, assumed) .....

Fault .....

Some geological boundaries after Neale (1963)

Figure 6-1. Geology of the White Point pluton. See Figure 1-1 for location of map area.

faulted, but generally the contact is a nonconformity with arkosic clastic rock derived from the underlying granite lying on an irregular spheroidally weathered granite paleotopography.

PLUTONIC ROCKS

FIELD RELATIONS

Although generally pale pink and leucocratic, the granite rocks of the White Point pluton show considerable variation in colour, mineralogy, and texture from one outcrop to another and even within one outcrop. Colour varies from deep maroon to pale pink. The amount of biotite present varies from 0 to 5 per cent or more. Foliation produced by alignment of biotite and in some places elongation of quartz grains varies from moderate to weak to absent.

In most areas exposure is too limited to trace the relationships between these granitic varieties, although in one outcrop along the Cabot Trail, light maroon granite is cut by pale pink granite containing fewer biotite crystals. However, such contacts between granite varieties are rarely found and in the coastal section east of White Point, where exposure is nearly continuous, the changes are gradational. They show no systematic relation to geographic area and could not be mapped as separate subphases. They appear to be local variations, approximately synchronous in age. Granitic dykes in adjacent country rock show a similar range of variants.

The foliation in the White Point pluton is not related to the margins of the pluton. It is interpreted to be the result of syntectonic crystallization of the magma. In places a local very strong foliation is developed, related to zones of shearing within the granite which probably formed during the final stages of crystallization of the magma. The foliation is somewhat irregular, but generally trends northeast and is steeply dipping. Typical orientations are shown on Figure 6-1.

Xenoliths of gneissic country rocks are common. Limited exposure generally prevented the tracing of their extents. Contacts with the granite are always sharp, with no evidence of chilling or contamination.

Randomly oriented pegmatite and aplite dykes are very abundant in the granite and adjacent country rocks. Crosscutting relations show that the aplite is younger. The pegmatite dykes are commonly 1 to 2 m in width, whereas the aplites are generally smaller.

A small body of coarse grained foliated granodiorite is exposed on the Cabot Trail where Trout Brook crosses the highway. It is cut by dykes of granite and pegmatite, and contains xenoliths of gneiss and amphibolite. Its relationship to the White Point pluton is not clear, although it is probably younger than the gneissic granodiorite of the country rocks.

A large dyke of dioritic composition cuts the granite at two localities near White Point (Fig. 6-1). It is 20 m in width and is cut by aplite dykes. It exhibits strong foliation which appears to be the result of both flow and shearing. Several mafic dykes 2 or 3 m in width also cut the granitic rocks, especially in the vicinity of Rachel Brook (Fig. 6-1).

PETROGRAPHY

Granodiorite

A small body of coarse grained foliated granodiorite exposed on the Cabot Trail consists of plagioclase (55%), quartz (18%), alkali feldspar (17%) and biotite (10%) in allotriomorphic granular texture. The plagioclase is zoned with an average composition of andesine. Quartz and alkali feldspar (orthoclase?) are interstitial. The biotite is pleochroic in shades of green and olive green and defines the foliation by parallel alignment. Accessory apatite is unusually abundant as small euhedral to subhedral crystals. Other accessories include sphene, zircon, opaques, and epidote.

Granite

The colour variation from maroon to pale pink in the granite does not reflect any obvious mineralogical variation. The granite contains plagioclase and alkali feldspar in proportions ranging from approximately equal to a predominance of plagioclase so that the rock grades into granodiorite (Fig. 6-2a). The plagioclase is anhedral to subhedral and generally of oligoclase composition. The alkali feldspar is microcline with well developed cross-hatch twinning. Quartz comprises 20 to 30 per cent of the rock and occurs as anhedral grains and in interstitial myrmekitic intergrowths with plagioclase. Myrmekite is present in virtually every thin section, although the amount varies from minor to 5 to 10 per cent. Muscovite and biotite are the other major minerals in the granite. Most samples contain both muscovite and biotite, but muscovite is absent from some and a few extremely leucocratic samples contain virtually no biotite. Some muscovite is secondary, but most occurs as large subhedral flakes of primary origin. The biotite is pleochroic in shades of brown and olive green and is partially replaced by chlorite in some samples. Apatite is an abundant accessory mineral, occurring in relatively large subhedral crystals. Zircon occurs rarely as inclusions in biotite. Opaques are virtually absent from most samples.

The texture in the granite is allotriomorphic granular, with grain size varying from fine to medium. Foliation due to alignment of biotites, visible in hand specimen, is not generally obvious in thin section due to the relatively small number of biotite flakes.

Pegmatite

Pegmatites are generally simple in form and mineralogy, consisting of quartz, alkali feldspar, and muscovite. Scattered garnet crystals are usually present. Textbook-quality graphic textures are developed in some dykes.

Aplite

Aplites have sugary, equigranular textures dominated by microcline and quartz. Garnet crystals are typically scattered throughout.

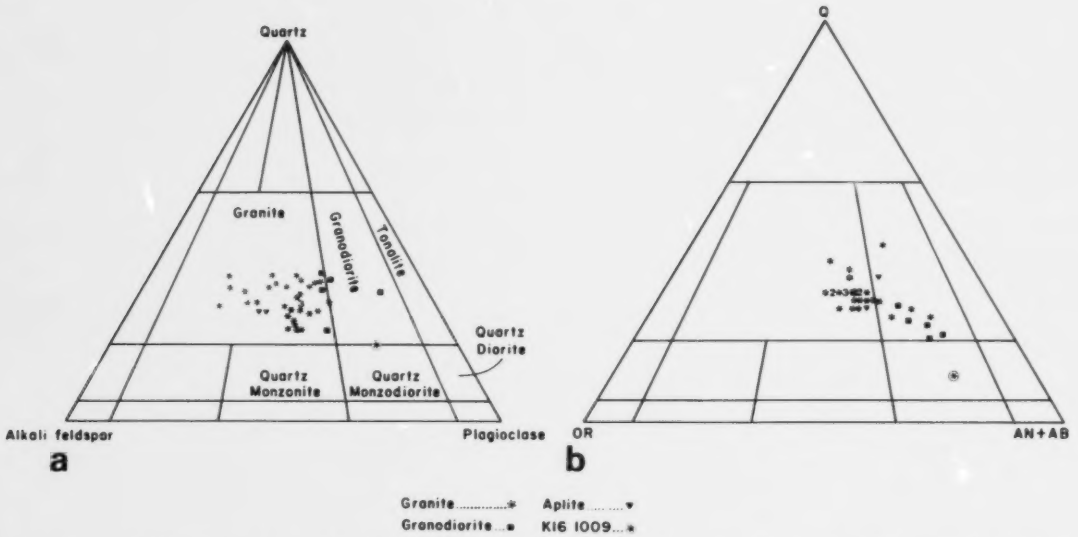


Figure 6-2. Modal mineralogy (a) and normative mineralogy (b) for White Point pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite.

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies for samples from the White Point pluton are presented in Appendix D. The average analyses and standard deviations derived from 32 samples of "granite" from the White Point pluton are listed in Table 6-1. Average analyses of five samples classified as granodiorite or transitional to granodiorite on the basis of feldspar ratios are grouped separately because they are somewhat distinctive in chemistry. Also listed separately are analyses of aplite dykes and the foliated granodiorite. These chemical data are displayed on silica variation diagrams (Fig. 6-3), together with linear regression lines derived from "unmineralized" plutons of this study and Gribble (1969).

The rocks are generally rich in SiO_2 and the range of silica values is small so trends are rather poorly developed on the silica variation diagrams (Fig. 6-3). However, TiO_2, Al_2O_3, Fe_2O_3T, MnO, MgO, CaO, P_2O_5 and possibly Na_2O show negative correlation with SiO_2 and K_2O shows positive correlation. The foliated granodiorite and the five granodiorite samples are lower in SiO_2 and generally show corresponding differences in other major element oxides, although the foliated granodiorite contains anomalously high MnO. In general oxide abundances are consistent with those of typical granites (Gribble, 1969) and other granites of this study. The pluton is remarkably homogeneous considering the area over which samples were collected. Most scatter occurs in K_2O and Na_2O, related to varying proportions of microcline and oligoclase.

All samples are oversaturated in silica and normative compositions (Fig. 6-2b) are similar to modal compositions (Fig. 6-2a). As anticipated from the presence of primary muscovite, the White Point pluton is somewhat peraluminous, with many samples containing small amounts of normative corundum (Appendix D).

Trace Element Geochemistry

Averages and standard deviations for trace element analyses are compiled in Table 6-1. The data are also displayed on silica variation diagrams (Fig. 6-4), together with regression lines derived from the data from "unmineralized" plutons of this study, including White Point, and Gribble (1969). The small range of SiO_2 values in the White Point pluton precludes the development of distinct trends.

Arsenic values are generally between 3 and 8 ppm, with a few higher values, similar to the range for other plutons of this study.

Barium displays a broad range, with a sharp decrease in the most silicic samples. The granodiorites have moderate Ba contents.

Copper is low in all samples.

Fluorine is low and similar to other plutons of this study, except for the foliated granodiorite sample which is somewhat higher in F. No obvious reason for the anomalous value was apparent in the petrography of this sample.

Lead values are generally somewhat higher than in other granites of this study, and one sample contains over 200 ppm. No petrographic reflection of this high Pb content was apparent.

Molybdenum values are about 2 ppm.

Rubidium displays a broad range, and more or less an inverse relationship with Ba. As Rb shows a positive correlation with K_2O, and Ba a positive correlation with Na_2O, these elements presumably occur, respectively, in the microcline and plagioclase.

Table 6-1. Average analyses and standard deviations for the four rock types in the White Point pluton.

	Foliated Granodiorite (n = 1)	Granodiorite (n = 5)	Granite (n = 32)	Aplite (n = 2)
SiO_2	63.14	67.81 ± 2.29	73.20 ± 1.16	74.02 ± 0.60
TiO_2	0.73	0.38 0.21	0.13 0.05	0.04 0
Al_2O_3	18.35	16.18 1.09	14.15 0.80	14.47 0.35
Fe_2O_3T	3.30	2.65 1.08	1.43 0.24	0.70 0.01
MnO	0.02	0.03 0.02	0.01 0	0.01 0
MgO	1.57	1.01 0.76	0.26 0.11	0.08 0.08
CaO	4.50	2.76 0.75	1.58 0.38	1.15 0.45
K_2O	2.68	2.98 0.67	4.40 0.74	3.88 0.79
Na_2O	4.75	4.59 0.59	3.93 0.58	4.38 0.01
P_2O_5	0.21	0.17 0.09	0.08 0.03	0.04 0
As	14	4 ± 2	7 ± 3	5 ± 2
Ba	860	739 255	463 264	13 8
Cu	15	7 6	4 10	1 1
F	840	670 360	430 90	400 0
Pb	22	29 7	44 34	28 6
Mo	1	1 1	15 72	2 1
Rb	95	135 28	216 59	431 62
Sr	790	676 225	244 233	67 12
S	60	150 250	30 20	20 10
Sn	2	4 2	4 4	5 1
U	4	2 1	3 2	3 1
Zn	65	60 26	41 13	≈0

Strontium shows a negative correlation with SiO_2, and a pattern similar to that of Ba, with a marked decrease in silicic samples.

Sulphur is uniformly low, except in one granodiorite sample.

Tin contents are generally low but show more spread than in other plutons.

Uranium concentrations are generally "average" but show some high values (up to 12 ppm), and the foliated granodiorite appears to be anomalously high in U.

Zinc concentrations are similar to those in other granites of this study and Gribble (1969).

ECONOMIC GEOLOGY

No economic mineral deposits are known to be associated with the White Point pluton. The abundant pegmatites associated with the pluton are mineralogically simple and apparently barren of economic minerals.

AGE

On the basis of field evidence, the White Point pluton is pre-Carboniferous in age. Cormier (1972) determined a Rb/Sr isochron age of 403 ± 22 Ma (Keppie and Smith, 1978) for ten whole-rock samples and two potassium feldspar samples from the White Point pluton and similar plutons to the south. However, the data show considerable scatter.

Samples of three pegmatite dykes from the White Point pluton were also analyzed and yielded an isochron age of 365 ± 12 Ma.

To confirm these ages, a suite of samples from the White Point pluton was dated by the Rb/Sr method, and yielded an age of 386 ± 1 Ma (R. F. Cormier, written communication, 1981).

SUMMARY

The White Point pluton consists primarily of weakly foliated muscovite-biotite granite intruded by abundant dykes of pegmatite and aplite. It is Devonian in age and intruded a metamorphic terrane of uncertain, but probable Precambrian age. The pluton is overlain nonconformably by Carboniferous sedimentary rocks.

The plutonic rocks are generally felsic in composition with contents of SiO_2 in excess of 70 per cent. They tend to be somewhat peraluminous. Major and trace elemental abundances are typical for granitic rocks. However, abundances of Pb, Sn, and U are slightly higher than in other plutons of this study.

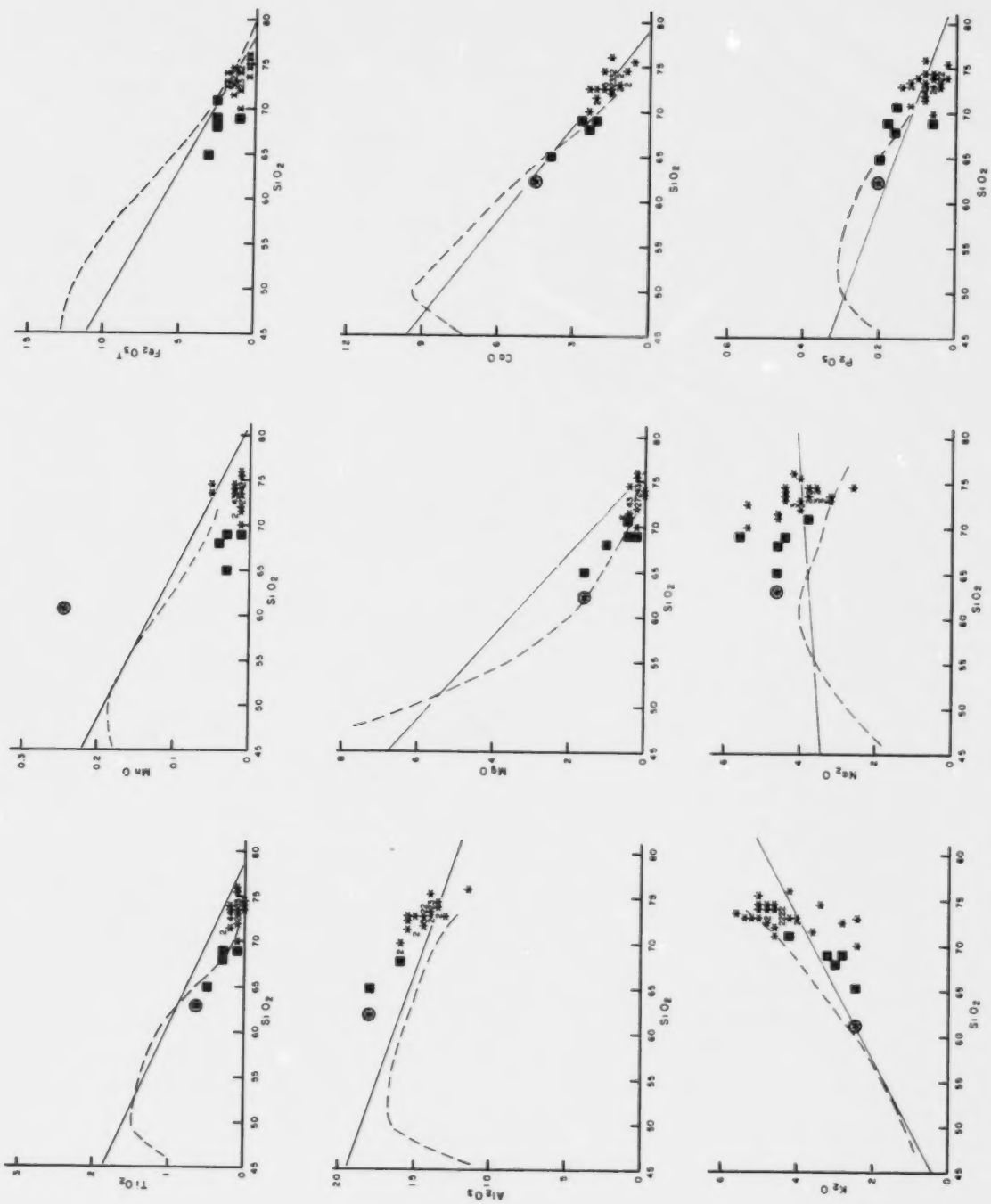


Figure 6-3. Silica variation diagrams for major element oxides in the White Point pluton. Symbols as in Figure 6-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic

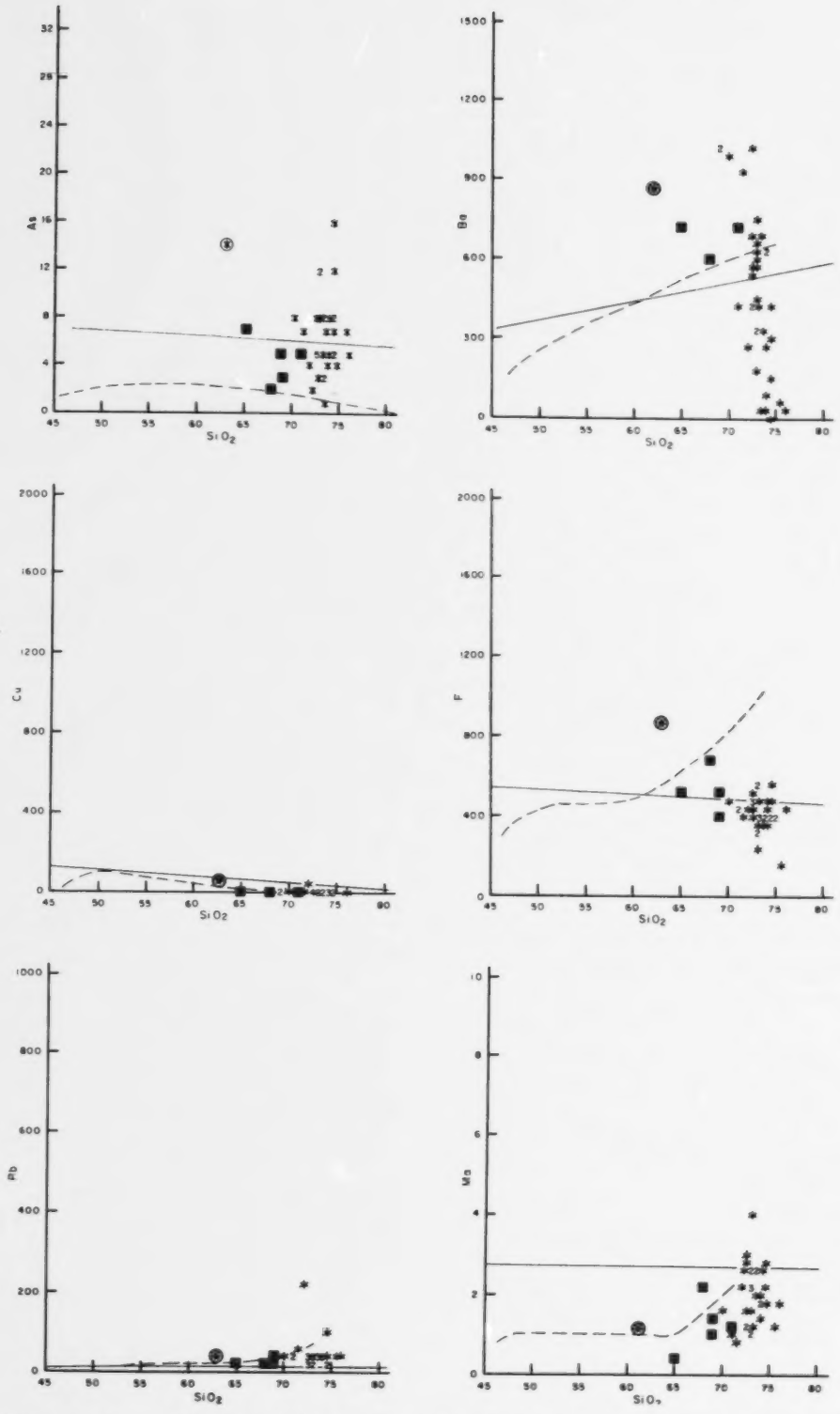


Figure 6-4. Silica variation diagrams for trace elements in the White Point pluton. Symbols and lines as in Figures 6-2 and 6-3 respectively.

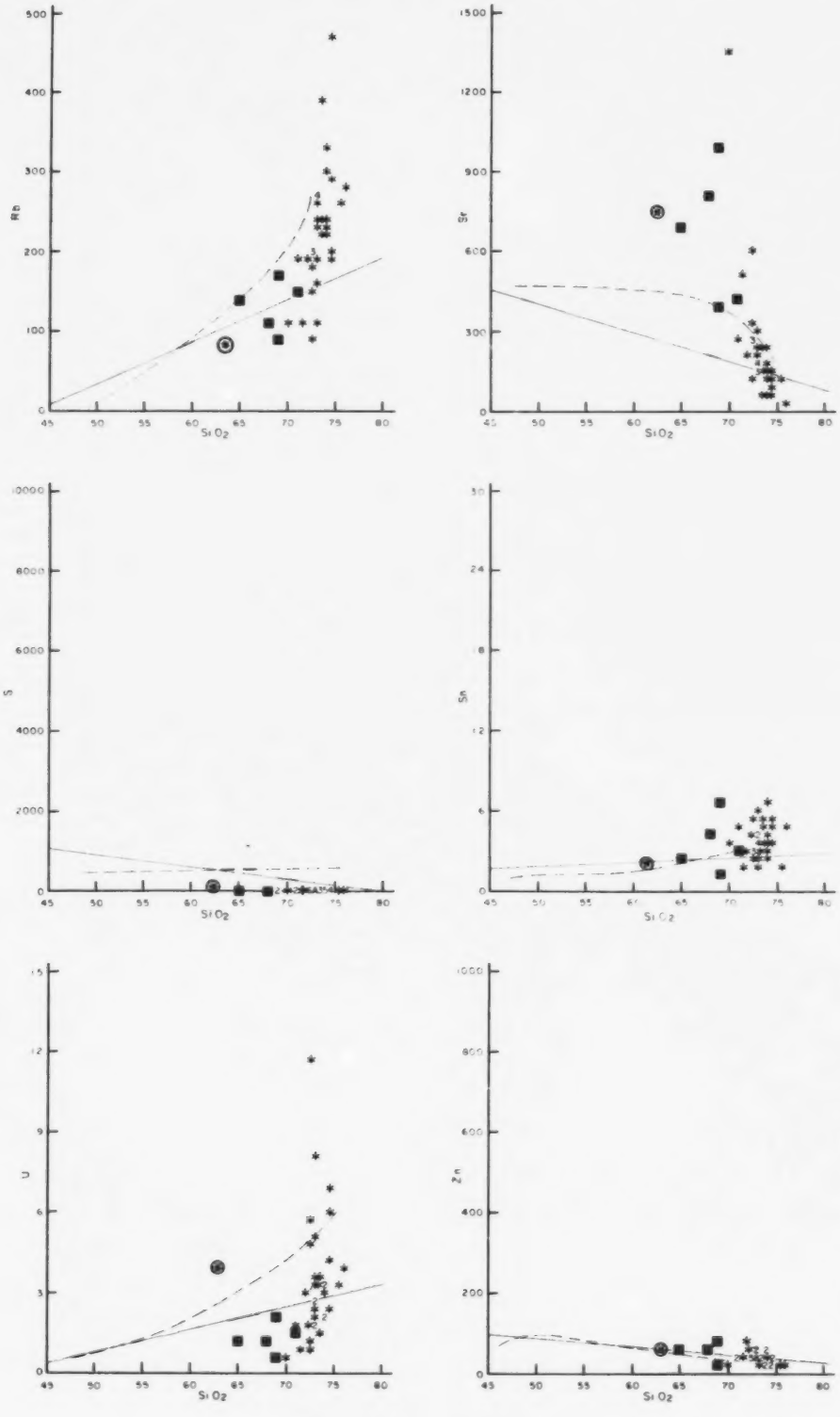


Figure 6-4. Continued.

CHAPTER 7
GILLIS MOUNTAIN PLUTON

INTRODUCTION

LOCATION AND ACCESS

The Gillis Mountain pluton is a small composite dioritic-granitic intrusion in southeastern Cape Breton Island. The pluton forms a local topographic high, Gillis Mountain, 25 km south of Sydney (Fig. 1-1). It is about 6 km^2 in area and subelliptical in shape, with its long axis trending north (Fig. 7-1).

Gillis Mountain is flat-topped, with its top forming part of the tilted peneplain of the region (Weeks, 1954). The area is thickly wooded and glacial till covers much of the terrane. As a result, outcrops are small, sporadic, and of poor quality over most of the mountain. No exposure was found in the south-central swampy area of the pluton. A trail crossing the north-central portion of the pluton, and six trenches dug by Noranda Exploration Company Limited in 1966-67 provided areas of good exposure which, combined with natural outcrops, enabled adequate mapping and sampling of the intrusion.

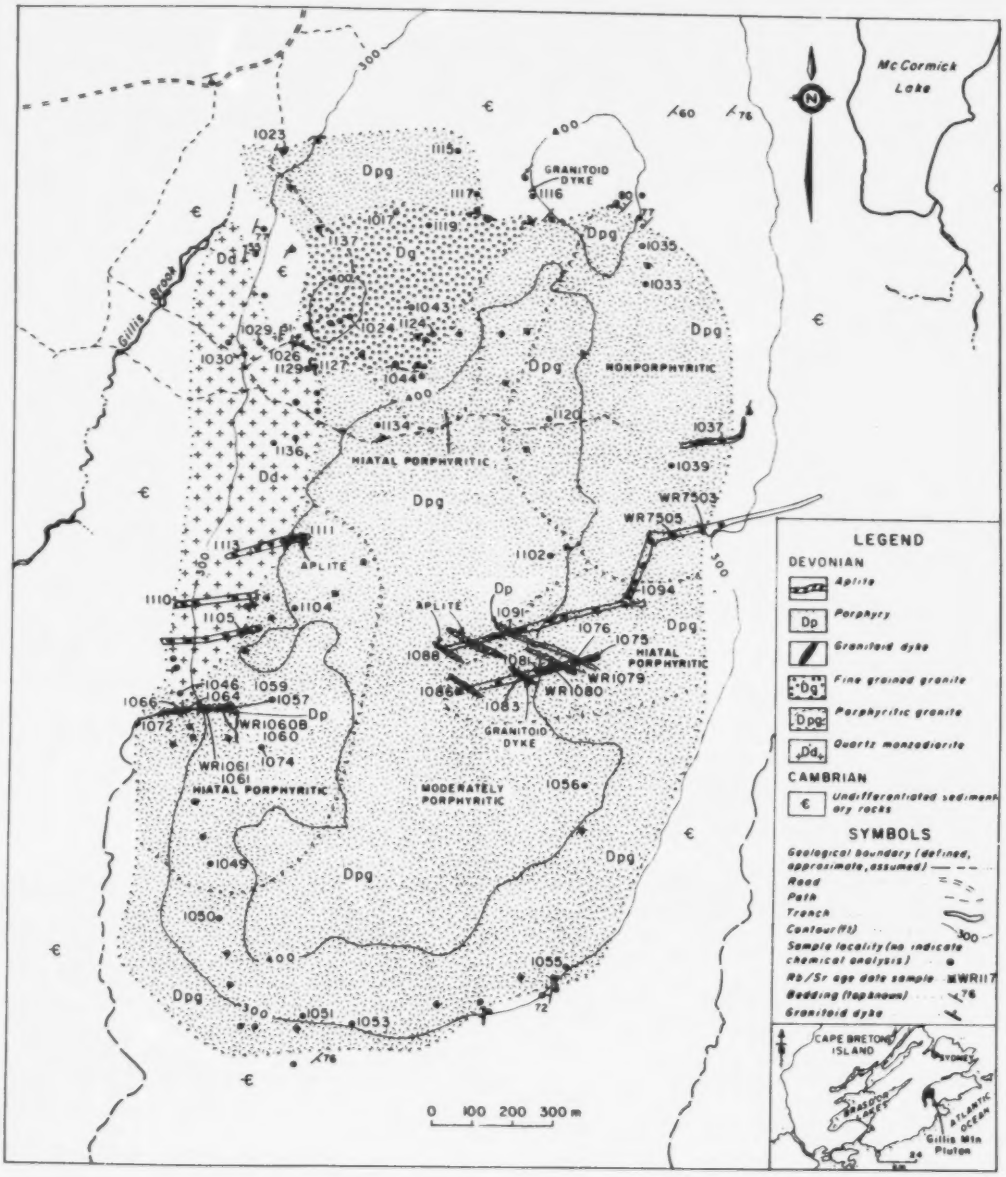


Figure 7-1. Geology of the Gillis Mountain pluton.

PREVIOUS WORK

Weeks (1954) included the Gillis Mountain pluton in his regional mapping of southeastern Cape Breton Island, and described it as "a small stock of coarse to fine pinkish granite, some of which may be syenitic in composition". No detailed work was undertaken, and no references were made to distinct phases or to mineralization.

Reporting on an exploration program by Noranda Exploration Company Limited, Hawkes (1967) described the intrusion as a granitic plug and distinguished two main phases, a granitic phase and a "dioritic differentiate?", with chalcopyrite and minor molybdenite occurring primarily along fractures within the diorite body. Stream silt and soil samples were analyzed for Cu and Mo, and anomalous zones were indicated in several parts of the pluton. However no detailed geochemical or petrological studies were done on the granitoid rocks themselves.

On the basis of limited petrographic studies, Chatterjee (1976) referred to the Gillis Mountain pluton as a granodioritic intrusion in which Mo-Cu mineralization occurs both in the contact aureole and along fractures and faults within the pluton. He concluded that mineralization was formed during and immediately after the emplacement of the intrusion. The mineralization has been described as having "porphyry affinities" (Kirkham and Soregaroli, 1975) and the pluton as having been affected by potassic alteration (Hollister et al., 1974; O'Reilly, 1977).

The age of the Gillis Mountain pluton was previously found to be 361 ± 25 Ma by the Rb/Sr method, on the basis of the biotite and whole rock analyses of a single sample (Cormier, 1972; Keppie and Smith, 1978).

GEOLOGICAL SETTING

COUNTRY ROCKS

The Gillis Mountain pluton intruded shales and siltstones of Early to Middle Cambrian age (Weeks, 1954). Prior to the intrusion these sedimentary rocks had been folded on northeast-trending axes, forming a broad synclinal structure in the area of Gillis Mountain.

CONTACT RELATIONS

The Gillis Mountain pluton is typical of a high-level intrusion in that the intrusive rocks have sharp, strongly discordant contacts with the country rocks and structures within the country rocks are relatively undisturbed.

The actual contacts are generally poorly exposed due to swampy terrain and glacial deposits on the margins of Gillis Mountain. Rocks in the immediate area of the contact have been subjected to contact metamorphism and consist of medium- to dark-grey fine grained hornfels with some quartzose bands. They are generally steeply dipping (greater than 70°) although the dip direction is variable. Sedimentary structures are well preserved, and include fine-scale laminations and current bedding, both of which are very clear on weathered surfaces.

The western contact is exposed in Trench 4 (Fig. 7-1) where quartz monzodiorite is in contact with slightly brecciated hornfels. The contact is steeply dipping and trends approximately north-south. Chilling is not notable in the quartz monzodiorite.

The contact between the country rocks and porphyritic granite is exposed at several localities along the northern boundary of the pluton. It is sharp and almost vertical, with the granite cutting the regional strike of the sedimentary rocks nearly at right angles. Xenoliths are abundant in the granite for distances of several metres from the contact, but chilling of the granite is not apparant.

CONTACT METAMORPHISM

Poor exposure of the sedimentary rocks in the swampy terrain surrounding Gillis Mountain prevented detailed study of the contact aureole except immediately adjacent to the contact. There mineral assemblages are indicative of medium grade contact metamorphism, with the development of cordierite and andalusite. Typical mineral assemblages include:

cordierite + muscovite + biotite + quartz
± andalusite ± K-feldspar ± amphibole

Textures are granoblastic. Both the biotite and amphibole are partially altered to chlorite.

This medium-grade metamorphic mineral assemblage adjacent to the contacts implies temperatures in the range of 500° to 580°C (Winkler, 1976). The temperature of the felsic to intermediate magma forming the Gillis Mountain pluton is not likely to have been less than 800°C, and temperatures adjacent to the contacts would have been in the order of 545°C if the depth of intrusion were 1.2 km and 660°C if the depth were 5 to 6 km (Jaeger, 1957). Thus the medium-grade metamorphic assemblage in the contact aureole suggests a very shallow depth of emplacement for the pluton, certainly much less than 5 to 6 km and perhaps as shallow as 1 km. The mineralogy and texture of the intrusion itself also support a very shallow depth of emplacement, as discussed below.

PLUTONIC ROCKS

FIELD RELATIONS

The Gillis Mountain pluton is a composite body consisting of three main phases cut by minor intrusions and dykes (Fig. 7-1). The main phases are quartz monzodiorite and two different types of granite: porphyritic granite and fine grained granite.

The quartz monzodiorite forms an elongate body, 1200 m in length along the northwestern margin of the pluton. It is the oldest phase of the intrusion, and occurs in sharp contact with the granitic phases which are chilled against it.

The porphyritic granite forms more than two thirds of the exposed portion of the pluton. Al-

though generally porphyritic, it includes three distinct, though gradational, textural variants. These include a hiatal porphyritic subphase (which in its extreme form resembles a rhyolite porphyry), a moderately porphyritic subphase and a microporphyritic subphase.

The fine grained granite occurs in a small subcircular body largely surrounded by porphyritic granite near the northern end of the pluton. Field evidence does not provide clear indication of the relative ages of these two granitic phases due to poor exposure. However, on the basis of chemical characteristics (described later) the fine grained granite is considered to be younger.

Minor phases include granitic porphyry, aplitic, and granitoid dykes which generally trend northwest-southeast, parallel to the major direction of jointing in the pluton. Apparent offsets of aplitic dykes between trenches 1 and 2 may be the result of intrusion, in part, along a second set of joints trending northeast-southwest.

These two sets of joints are well developed in the pluton and in country rocks immediately adjacent. Both are steeply dipping with spacing 0.5 to 1 m, although locally the rocks are highly fractured with joint spacing on the scale of centimetres. Pyrite, chalcopyrite, and molybdenite are common on joint surfaces. A third subhorizontal set of joints is less well developed and apparently unmineralized.

PETROGRAPHY

Quartz Monzodiorite

The quartz monzodiorite is fine grained and dark grey in colour. Chalcopyrite and pyrite occur both as disseminations and along fractures. Microphenocrysts of plagioclase, amphibole, and rarely pyroxene up to 4 mm in length are set in a fine grained groundmass of plagioclase, quartz, alkali feldspar, biotite, and amphibole. The groundmass textures are somewhat variable, with quartz and feldspar occurring either as irregular or myrmekitic intergrowths.

The plagioclase microphenocrysts generally comprise 50 to 60 per cent of the rock. They are euhedral to subhedral and show strong normal zoning. Microprobe analyses indicated ranges of An_{35-56} for core compositions and An_{23-35} for rims (O'Beirne, 1979). Alkali feldspar is always subordinate to plagioclase, generally forming less than one third of the total feldspar. Optical determinations of 2V less than 20° indicated that the alkali feldspar is sanidine. Quartz occurs in the groundmass intergrown with feldspar and rarely exceeds 8 to 10 per cent (Fig. 7-2a).

The mafic minerals comprise 15 to 20 per cent of the rock. Pyroxene, where present, is generally hypersthene commonly rimmed by augite and/or hornblende. The hornblende is pleochroic in shades of green and also occurs as subhedral microphenocrysts or as euhedral grains in the groundmass. Biotite occurs as disseminated subhedral to anhedral grains. It may occur as an alteration product of amphibole, but much appears to be primary.

Accessories include abundant apatite, rare sphene, and abundant opaques which include both pyrite and chalcopyrite in some specimens.

Microprobe analyses of feldspars, amphiboles, and biotites are given by O'Beirne (1979).

Porphyritic Granite

In hand specimen the porphyritic granite varies from pinkish-buff to medium grey. Only the hiatal porphyritic subphase appears notably porphyritic in hand specimen. The porphyritic granite is host for chalcopyrite, molybdenite, and pyrite mineralization, occurring both as disseminations and along fractures.

The mineralogies of the three subphases of the porphyritic granite are broadly similar. They consist of quartz (15% to 20%), plagioclase (35% to 40%), and alkali feldspar (25% to 35%) together with biotite and amphibole (8% to 12%). Accessories include zircon, apatite, sphene, and opaques.

Plagioclase occurs both as phenocrysts and in the groundmass. It is euhedral to subhedral and shows normal zoning, with core compositions as calcic as An_{45} and rims as sodic as An_{14} (O'Beirne, 1979). Alkali feldspar also occurs both as subhedral phenocrysts and as euhedral groundmass grains. In the microporphyritic subphase, the alkali feldspar is anhedral. Optical determinations of 2V commonly gave values about 12°, indicating sanidine.

The amphibole is pleochroic in shades of green and occurs as euhedral crystals up to 0.4 mm in length. It is commonly altered to biotite and chlorite. Microprobe analyses confirmed that it is hornblende (O'Beirne, 1979).

Biotite occurs as dark grains, pleochroic in shades of brown and reddish-brown. Some of the biotite has formed from amphibole, and in the extreme completely pseudomorphs it. However, much of the biotite is of direct magmatic origin as evidenced by common occurrence of almost perfect hexagonal shapes and corroded margins. In some sections the crystals are somewhat bent, suggesting minor deformation.

Alteration includes sericitic alteration of feldspars with plagioclase more strongly affected than coexisting alkali feldspar. Amphibole shows varying degrees of alteration to biotite and both amphibole and biotite show minor chloritization.

Microprobe analyses of feldspars, amphiboles, and biotites from the porphyritic granite are given by O'Beirne (1979).

Fine Grained Granite

In hand specimen this granite is fine grained with clouded white euhedral plagioclase crystals in a pale grey groundmass. Xenoliths, now represented by fine grained "clots" of biotite, quartz, and alkali feldspar about 1 cm in dia-

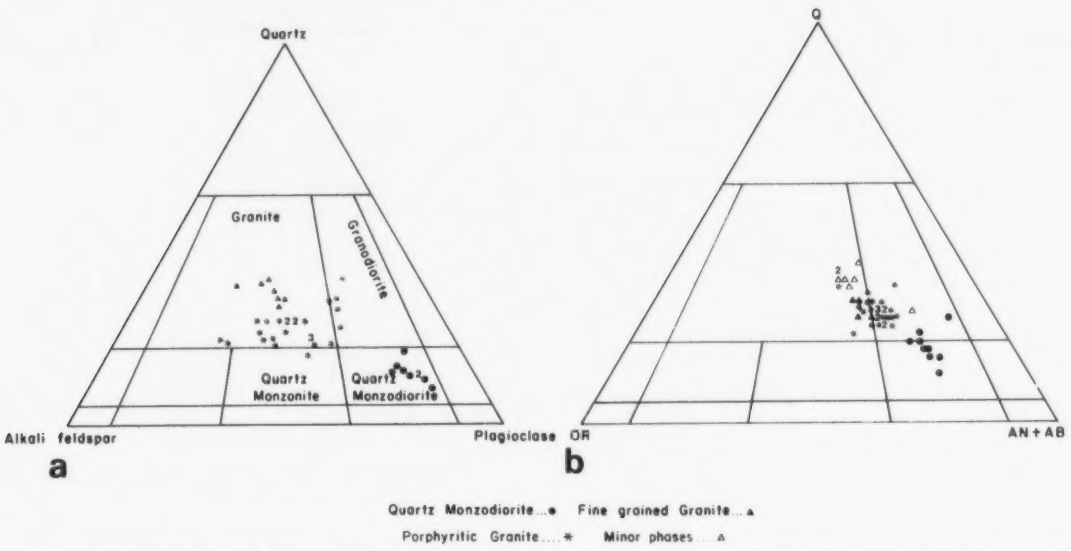


Figure 7-2. Modal mineralogy (a) and normative mineralogy (b) for Gillis Mountain pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus albite.

meter are common. Pyrite and chalcopyrite occur in numerous microfractures and more rarely as disseminations.

In thin section euhedral to subhedral crystals of plagioclase, forming up to 35 per cent of the rock, stand out in a matrix of alkali feldspar (35% to 45%), quartz (20% to 25%), and biotite (<10%). The texture is hypidiomorphic inequigranular. Normal zoning occurs only towards the rims of the plagioclase crystals, with core compositions ranging from An_{25} to An_{38} and rim compositions approximately An_{20} (O'Beirne, 1979). The alkali feldspar is anhedral and in places perthitic on a very fine scale. Values of 2V less than 20° indicate that it is sanidine, as in the other phases of the pluton. Quartz is interstitial. Amphibole where present is almost completely altered to biotite. Biotite occurs as disseminated glomeroporphyritic clusters, as the alteration product of amphibole, or in veinlets together with opaques. Accessories include apatite, zircon, opaques, and rare sphene.

Alteration of feldspars to sericite and biotite to chlorite is minor.

Minor Phases

The **granitic porphyry** is pink in hand specimen with abundant altered plagioclase phenocrysts. These phenocrysts in thin section are strongly zoned and extremely sericitized. Alkali feldspar in the groundmass is also extremely sericitized and identifiable only by a potassium feldspar stain (Appendix A). Quartz occurs as phenocrysts and in the groundmass. Scattered biotites and amphiboles have been almost completely chloritized. Chalcopyrite, pyrite, and molybdenite are relatively abundant. Other accessories include zircon, apatite, rare sphene, and opaques.

The **aplites** are pink in hand specimen with typical aplitic texture. In thin-section, ghost-like hematized plagioclase microphenocrysts occur in a sericitized microgranophyric groundmass. Pyrite and chalcopyrite occur in fractures.

The **granitoid dykes** with one exception are generally similar to the fine grained granite in mineralogy, although the texture is microgranophyric. The exception contains more plagioclase and is monzodiorite. Mineralization (pyrite and rare chalcopyrite) is minor in these bodies.

GEOCHEMISTRY

Major Element Geochemistry

Analytical data and CIPW normative mineralogies are presented in Appendix D. Average analyses and standard deviations for the various phases of the Gillis Mountain pluton are listed in Table 7-1. The data are displayed on silica variation diagrams (Fig. 7-3) together with linear regression lines derived from other plutons of this study as described in Chapter 1 and Gribble (1969).

The **quartz monzodiorite** is the most mafic phase of the pluton, with low SiO_2 and K_2O and high Al_2O_3, TiO_2, Fe_2O_3T, MgO, MnO, CaO, and P_2O_5 relative to the other phases. It is fairly homogeneous in major element geochemistry as indicated by small standard deviations in the average analysis (Table 7-1).

The **porphyritic granite** is intermediate in chemical composition between the more mafic quartz monzodiorite and the slightly more felsic fine grained granite. This phase is also quite homogeneous, and no systematic chemical differences are obvious among the three textural variants or with sample distribution over the pluton.

The **fine grained granite** is chemically similar to the porphyritic granite, but with somewhat higher SiO_2 and K_2O and lower MgO and CaO.

Table 7-1. Average analyses and standard deviations for the three main phases and the minor phases of the Gillis Mountain pluton.

	Quartz Monzodiorite (n = 9)		Porphyritic Granite (n =28)		Fine Grained Granite (n = 7)		Minor Phases (n = 7)	
SiO_2	60.14 ±	1.37	67.40 ±	1.10	68.27 ±	1.42	69.99 ±	3.62
TiO_2	1.39	0.11	0.62	0.07	0.62	0.07	0.40	0.23
Al_2O_3	16.29	0.74	15.07	0.64	14.83	0.29	13.92	1.08
Fe_2O_3T	7.77	0.74	4.01	0.50	3.94	0.23	2.80	1.50
MnO	0.11	0.03	0.05	0.01	0.05	0.01	0.03	0.03
MgO	2.60	0.34	1.39	0.17	1.14	0.15	0.70	0.54
CaO	4.81	0.36	2.70	0.53	2.18	0.29	1.58	1.24
K_2O	2.28	0.49	3.53	0.42	4.01	0.13	3.72	0.70
Na_2O	3.64	0.15	3.69	0.18	3.58	0.15	3.67	0.29
P_2O_5	0.36	0.04	0.15	0.03	0.13	0.03	0.12	0.09
As	8 ±	3	7 ±	3	5 ±	2	8 ±	1
Ba	797	87	882	112	938	90	700	351
Cu	168	197	202	556	85	115	76	90
F	630	100	510	120	620	70	390	120
Pb	18	8	99	199	103	156	109	175
Mo	4	1	4	2	5	1	3	1
Rb	101	20	170	28	159	17	212	82
Sr	465	35	302	38	244	25	179	84
S	2110	2550	1230	1510	2340	1420	1080	1500
Sn	2	<1	2	1	3	1	3	1
U	2	<1	4	<1	4	<1	6	3
Zn	84	20	153	198	154	134	348	751

Eight samples from the late **minor phases** were also selected for analysis. With the exception of the monzodioritic dyke exposed in Trench 1 (Fig. 7-1), these are generally more felsic than the main phases of the pluton.

With the exception of Na_2O, the major element oxides show moderate to good correlation with SiO_2 (Fig. 7-3). Only K_2O shows a positive correlation. The trends are consistent with a sequence of differentiation from quartz monzodiorite through porphyritic granite and fine grained granite to the late stage porphyries, granitoid dykes, and aplites. They are also typical of calc-alkalic rock series (Nockolds and Allen, 1953; Gribble, 1969), although the monzodiorite is enriched in P_2O_5 and TiO_2.

The diagrams show a gap in silica contents between 62 and 65 per cent. This gap is also apparent in TiO_2, Fe_2O_3T, and P_2O_5 contents and to a lesser degree in CaO, MgO, and MnO contents. It suggests the possibility that the quartz monzodiorite is a "cumulate" phase of the intrusion, and that the original magma was somewhat more felsic than the quartz monzodiorite.

All samples are oversaturated with silica. A plot of normative Q-Or-Ab+An (Fig. 7-2b) is broadly similar to modal Q-K-P (Fig. 7-2a). Many samples contain normative corundum (Appendix D), although the overall petrology is not typical of peraluminous granitoid rocks. The removal of alkalies in hydrothermal solutions might account for this tendency to alumina oversaturation.

Trace Element Geochemistry

Trace element data for the three main phases and late minor phases of the Gillis Mountain pluton are summarized in Table 7-1. The data for all analyzed samples are displayed on silica variation diagrams (Fig. 7-4) together with trends from Gribble (1969) and other plutons of the present study (Chapter 1). The main features of the data are discussed below, with the elements arranged in alphabetical sequence.

Arsenic contents are similar to those in other Cape Breton plutons and somewhat higher than those given by Gribble (1969) (see Appendix B).

Barium contents are high in all phases of the pluton and show only moderate degree of scatter and a weak positive correlation with SiO_2. The values are high compared to those in average calc-alkalic rocks and also in the "unmineralized" plutons of this study which also show more scatter in the felsic phases. The aplites contain very low Ba values.

Copper contents are extremely varied compared to other plutons of this study, and show large standard deviations in all phases. This is not surprising in a pluton with Cu mineralization, even though samples with obvious mineralization were not selected for analysis.

Fluorine displays a weak negative correlation with SiO_2, and values similar to those in the "unmineralized" plutons and typical calc-alkalic plutonic rocks.

Lead contents are consistently low in the quartz monzodiorite, but higher and more variable in the granitic and late phases. Lead is typically concentrated in the felsic phases of igneous rocks, but some of the values in Gillis Mountain granites are much higher and more variable than those in the "unmineralized" plutons of this study and average calc-alkalic plutonic rocks.

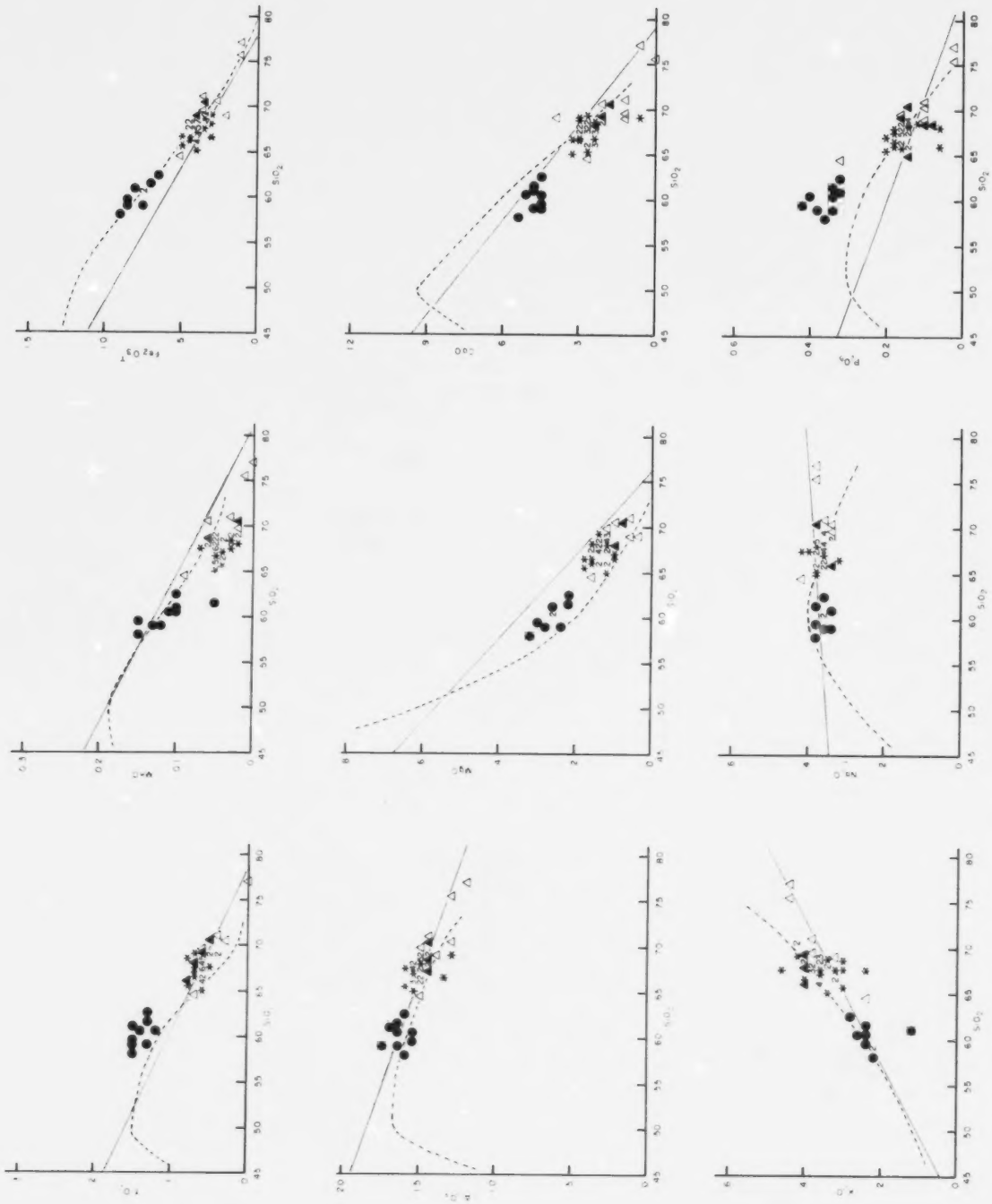


Figure 7-3. Silica variation diagrams for major element oxides in the Gillis Mountain pluton. Symbols as in Figure 7-2. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

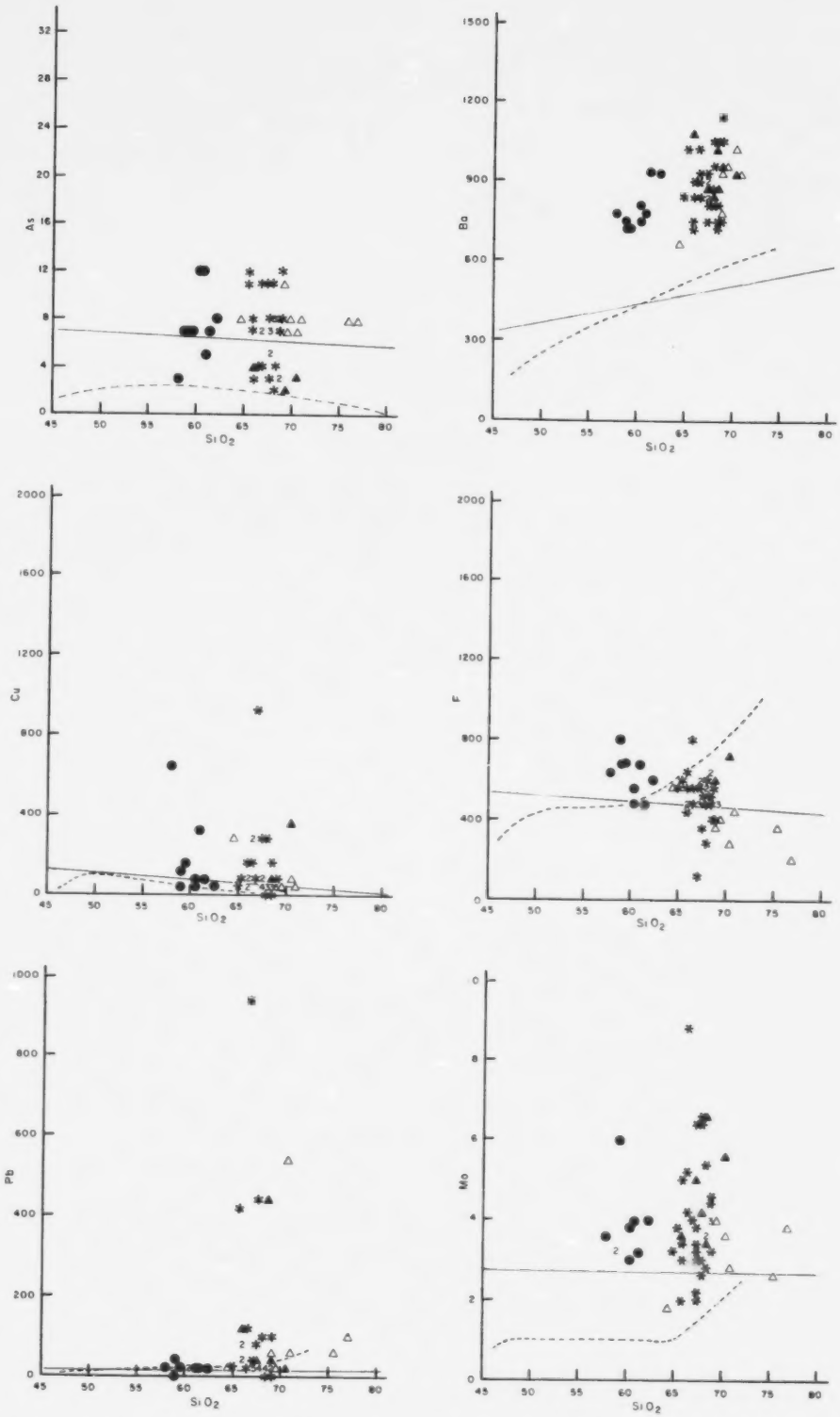


Figure 7-4. Silica variation diagrams for trace elements in the Gillis Mountain pluton. Symbols and lines as in Figures 7-2 and 7-3, respectively.

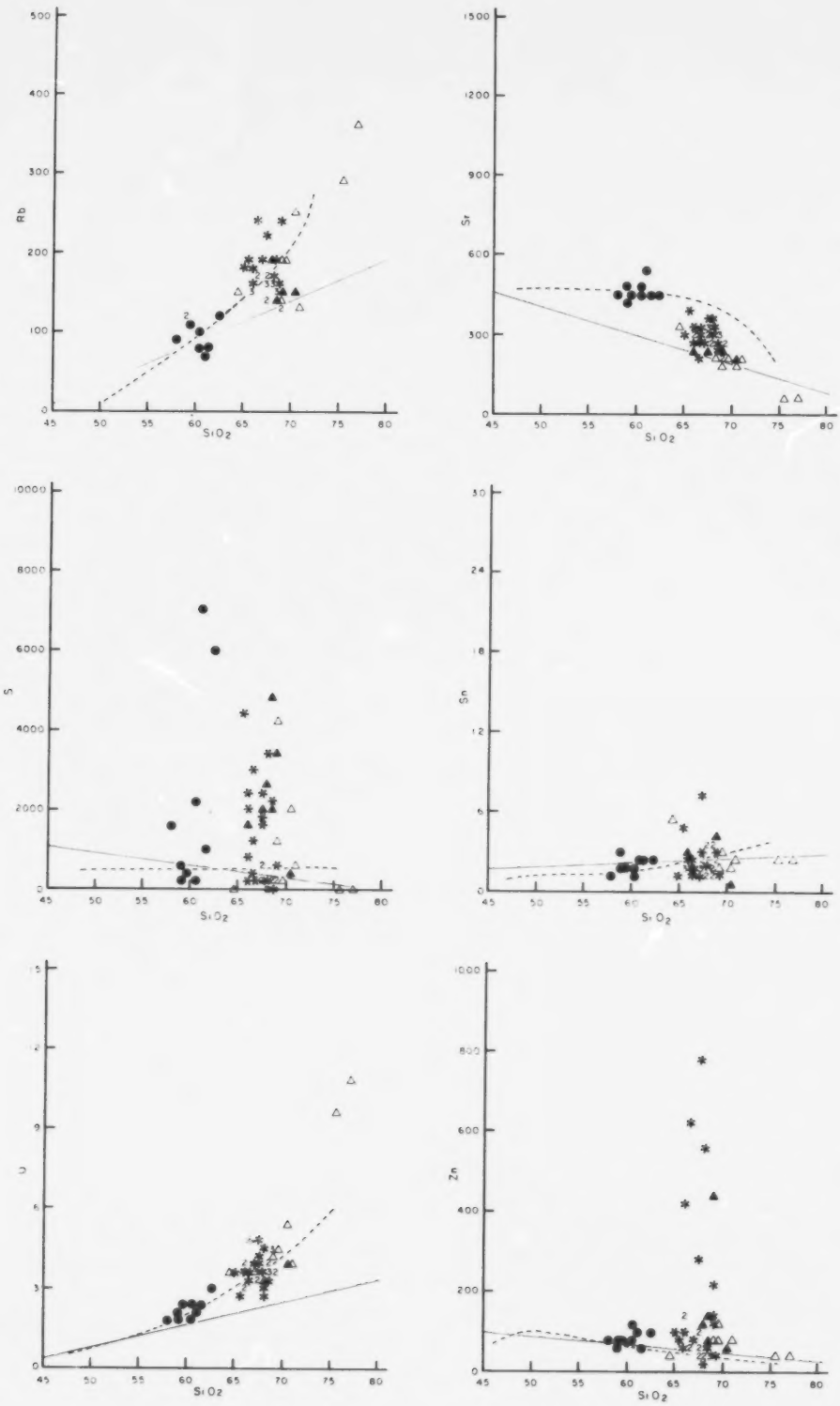


Figure 7-4. Continued.

Molybdenum values are low, but higher and more varied than those in the "unmineralized" plutons and typical calc-alkalic rocks.

Rubidium generally increases with increasing SiO_2, a pattern similar to that typical of calc-alkalic rocks. However, values are somewhat higher than in felsic phases of "unmineralized" plutons of Cape Breton Island.

Strontium shows a good negative correlation with SiO_2, also typical of differentiation series, and abundances similar to those reported by Gribble (1969) and in other plutons of this study, although Sr in the quartz monzodiorite is relatively higher than in the latter.

Sulphur values are extremely variable and generally higher than in typical calc-alkalic plutons or "unmineralized" plutons of this study.

Tin values are low and similar to those in typical calc-alkalic plutonic rocks and "unmineralized" plutons of this study.

Uranium displays a good positive correlation with SiO_2, with values almost identical to the trend reported by Gribble (1969). These tend to be higher than those in other plutons of this study.

Zinc, like lead, is low and reasonably constant in the quartz monzodiorite but higher and more variable in the granitic phases.

The areal distributions of abundances of Ba, Cu, Mo, Pb, S, and Zn in the Gillis Mountain pluton are shown in Figure 7-5. Although insufficient data points are present to make contours meaningful, visual comparisons show that the high values are scattered over the pluton and not concentrated in any particular area. There is surprisingly weak correlation among these elements at most sampling sites.

ECONOMIC GEOLOGY

Sulphides occur in all phases of the pluton as well as in adjacent metasedimentary rocks. Molybdenite is present predominantly in the porphyritic granite and granitic porphyries as small veinlets, irregular patches, and coatings on fracture surfaces. Pyrite with lesser chalcopyrite occurs as disseminations of erratic distribution in all phases and in adjacent hornfels. Brown staining from weathering of the sulphides marks pyrite-rich areas. These minerals also occur in small veinlets in association with biotite, quartz, and potassium feldspar. Rare quartz veins (approximately 15 cm in width) bearing pyrite, chalcopyrite, and molybdenite were observed in trenches in the porphyritic granite.

AGE

Previous data based on whole-rock and biotite analyses from one sample of the porhyritic granite yielded an age of 361 ± 25 Ma by the Rb/Sr isochron method (Cormier, 1972; recalculated by Keppie and Smith, 1978). The age was not considered very reliable due to the possibility of up-dating of biotite ages (Cormier, 1972). Hence samples with a suitable range of Rb/Sr ratios were analyzed as part of the present study. These included two samples of each of the quartz monzodiorite, porphyritic granite, and aplitic dykes. The resulting 12-point isochron is based on both whole-rock and mineral (potassium feldspar, quartz-plagioclase, and biotite) analyses. It indicates an age of 384 ± 10 Ma and as the biotite analyses fall on the isochron, no up-dating appears to have occurred, and the new age is in agreement (considering error limits) with the earlier date. The initial ratios overlap in the range of 0.704 and 0.705.

SUMMARY

The Gillis Mountain pluton is a high-level composite intrusion of Devonian age with abundant associated Cu-Mo mineralization. The pluton includes quartz monzodiorite, porphyritic granite, and fine grained granite, as well as later granitic and aplitic dykes. The rocks range chemically from intermediate to felsic and major and trace elements generally show good correlation with SiO_2. However, high means and standard deviations in Ba, As, Cu, Mo, Pb, Zn, and S compared to granitoid rocks of similar SiO_2 contents in Cape Breton Island and elsewhere probably reflect the fact that Gillis Mountain pluton is mineralized.

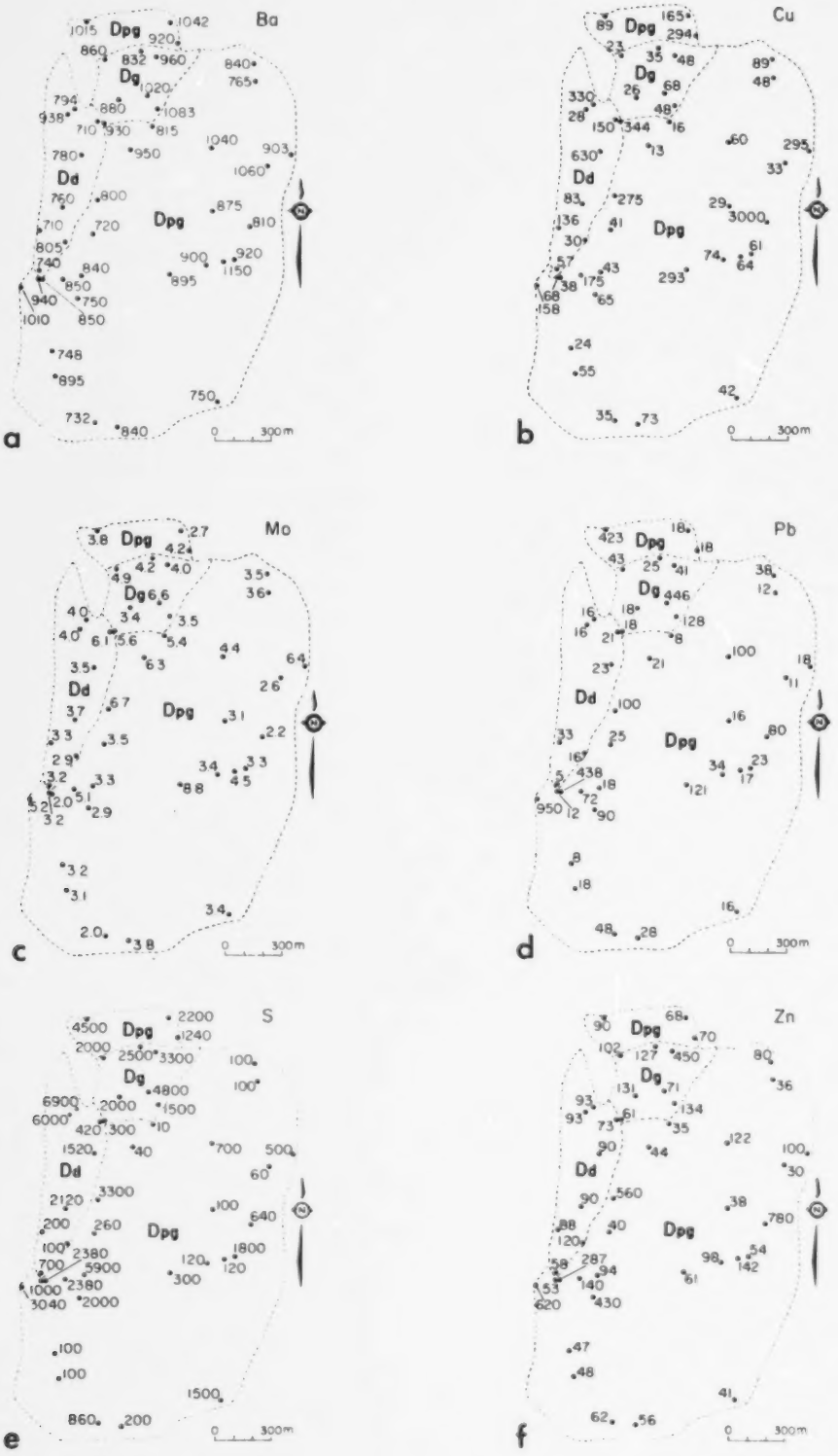


Figure 7-5. Selected trace element concentrations in samples from the Gillis Mountain pluton. Pluton outline and sample locations as in Figure 7-1. Dd = quartz monzodiorite; Dpg = porphyritic granite; Dg = fine grained granite.

CHAPTER 8
DEEP COVE PLUTON

INTRODUCTION

LOCATION AND ACCESS

A small granitic intrusion with associated dykes occurs at Deep Cove in southeastern Cape Breton Island (Fig. 1-1). Access to the area is by the unmaintained coastal road from Gabarus to Louisbourg (Fig. 8-1).

SIZE AND EXPOSURE

The main plutonic body at Deep Cove is inferred to be approximately 0.1 km^2 in area (Bingley, 1967; Sangster, 1977). It is exposed in streams above Deep Cove and in a bulldozed road adjacent to the streams. It has also been extensively drilled during exploration programs in the area (Forgeron, 1974; Sangster, 1977; S. Sears, personal communication, 1980). Associated dykes range in thickness from less than 1 m to 30 m and are well exposed in the coastal section northeast of Deep Cove.

PREVIOUS WORK

Copper and molybdenum mineralization in the Deep Cove area has been known since the late 1800's, and sporadic trenching, digging of shafts, and drilling had been carried out prior to more systematic geochemical and geophysical surveys during the 1960's. The area was mapped as part of the Louisbourg Project of the Nova Scotia Department of Mines (Bingley, 1967). Detailed mapping by Sangster (1977), as part of an exploration program by St. Joseph Explorations Limited, showed the extent of the pluton as well as some of the larger dykes along the shoreline. Sangster classified the plutonic rocks as monzonitic and described some aspects of their petrography, alteration, and mineralization. He compared the area to typical porphyry-type Cu deposits. Chatterjee (1976) compared the Deep Cove plutonic rocks and mineralization to those at Gillis Mountain on the basis of similarity in age (Cormier, 1972) and mineralogic features.

Structural aspects of the Deep Cove area were the subject of a study by Bourque (1977).

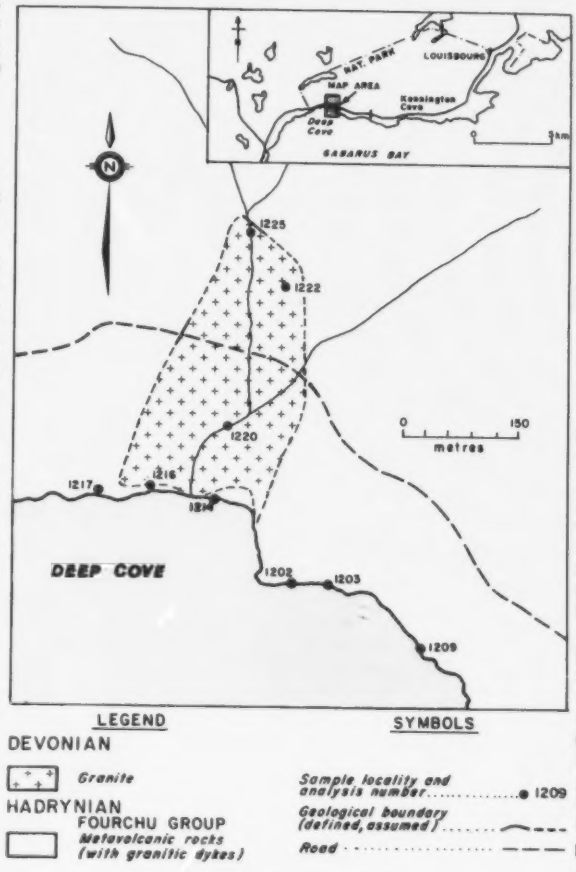


Figure 8-1. Location of sampling sites for analyzed rocks in or near the Deep Cove pluton. Samples from outside the pluton boundary are from granitic dykes.

However, no chemical analyses of the plutonic rocks at Deep Cove have been published.

The pluton has been the focus of a drilling program by Louisbourg Mines Ltd. during the summer of 1979 and currently by Amax Minerals Ltd.

GEOLOGICAL SETTING

The plutonic rocks of Deep Cove have intruded metavolcanic rocks of the Fourchu Group. These consist primarily of coarse- to fine-grained felsic pyroclastic rocks with some rhyolitic to andesitic flows which have been regionally metamorphosed to chlorite grade. Adjacent to the Deep Cove pluton they have been contact metamorphosed to hornfels (Sangster, 1977).

PLUTONIC ROCKS

FIELD RELATIONS

No mapping was done during the present investigation and the boundaries of the pluton are assumed to be as shown by Bingley (1967) and Sangster (1977). According to Sangster, the pluton consists of monzonite to quartz monzonite and granite, usually porphyritic. Variations within the pluton were ascribed to potassic metasomatism, rather than magmatic differentiation, on the basis of the lack of intrusive contacts between the variants, their textural similarities and the presence of potassium feldspar veining.

PETROGRAPHY

Some petrographic studies were reported by Sangster (1977). Samples collected during the present study are generally similar to those described by Sangster, although they are here generally classified as granite (Fig. 8-2a) following Streckeisen (1976). They consist of zoned plagioclase of albite/oligoclase composition (15% to 50%), sanidine and/or orthoclase (20% to 55%), quartz (20% to 35%), and biotite (3%). Amphibole is rarely present. Apatite, zircon, and sphene are common accessories. Textures are generally hypidiomorphic inequigranular in the dyke samples and porphyritic in the main body of the pluton, with phenocrysts of potassium feldspar in a fine grained groundmass. Petrographic descriptions of analyzed samples are presented in Appendix C.

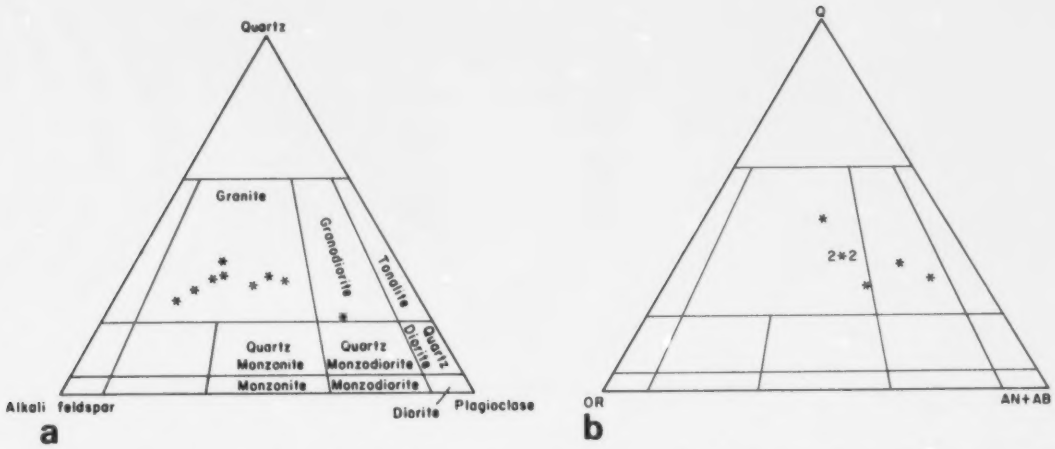


Figure 8-2. Modal mineralogy (a) and normative mineralogy (b) for Deep Cove pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR normative orthoclase; AN + AB = normative anorthite plus albite.

GEOCHEMISTRY

Major Element Geochemistry

The averages and standard deviations of analyses of nine samples from the Deep Cove pluton and associated dykes are listed in Table 8-1. The data are displayed on silica variation diagrams (Fig. 8-3). Best-fit lines derived from Gibble (1969) and other plutons in Cape Breton Island as described in Chapter 1 are shown for reference.

Silica contents range from 67 to 74 per cent in the Deep Cove suite. Major element oxides generally show patterns typical of other plutons in this study, although there is considerable scatter in K_2O and P_2O_5 is higher than average in rocks of similar silica levels.

The samples contain much more normative than modal plagioclase (Fig. 8-2a,b), presumably due to the occurrence of substantial Na in modal alkali feldspar. Like the Gillis Mountain samples, those from Deep Cove contain normative corundum, although otherwise lacking peraluminous characteristics. This is possibly the result of depletion of alkalies during hydrothermal activity.

Trace Element Geochemistry

The averages and standard deviations of the analyses are presented in Table 8-1. The analytical data are displayed on silica variation diagrams (Fig. 8-4) together with the best-fit lines derived from Gibble (1969) and other plutons in Cape Breton Island (Chapter 1).

Arsenic, fluorine, rubidium, strontium, and tin show patterns and concentrations similar to other granites in Cape Breton Island although one sample is high in As, and two in F.

Barium shows less scatter than is typical for felsic phases in other Cape Breton plutons and higher than average values. Uranium values are also somewhat higher than average.

The remaining elements Cu, Pb, Mo, Zn and S show larger standard deviations than in the unmineralized plutons, with some average values and other very high values.

Table 8-1. Average analyses and standard deviations for samples from the Deep Cove pluton and related granitic dykes.

	Granite (n = 9)	
SiO_2	71.72 ±	2.26
TiO_2	0.41	0.18
Al_2O_3	13.93	0.85
Fe_2O_3T	2.39	1.02
MnO	0.04	0.02
MgO	0.94	0.44
CaO	1.74	0.81
K_2O	3.73	1.07
Na_2O	3.46	0.50
P_2O_5	0.14	0.05
As	8 ±	4
Ba	798	88
Cu	73	85
F	570	150
Pb	50	41
Mo	6	2
Rb	178	53
Sr	225	74
S	2490	2980
Sn	3	2
U	6	1
Zn	230	186

ECONOMIC GEOLOGY

Molybdenite occurs in irregular patches in the granitic dykes and quartz veins in the Fourchu Group. It also occurs as sparse disseminations in the main plutonic body in association with pyrite, minor chalcopyrite, and trace amounts of sphalerite and bismuthinite. Potassic alteration in the plutonic rocks has suggested comparison with porphyry-type deposits (Sangster, 1977). Discussion of this alteration and the details of

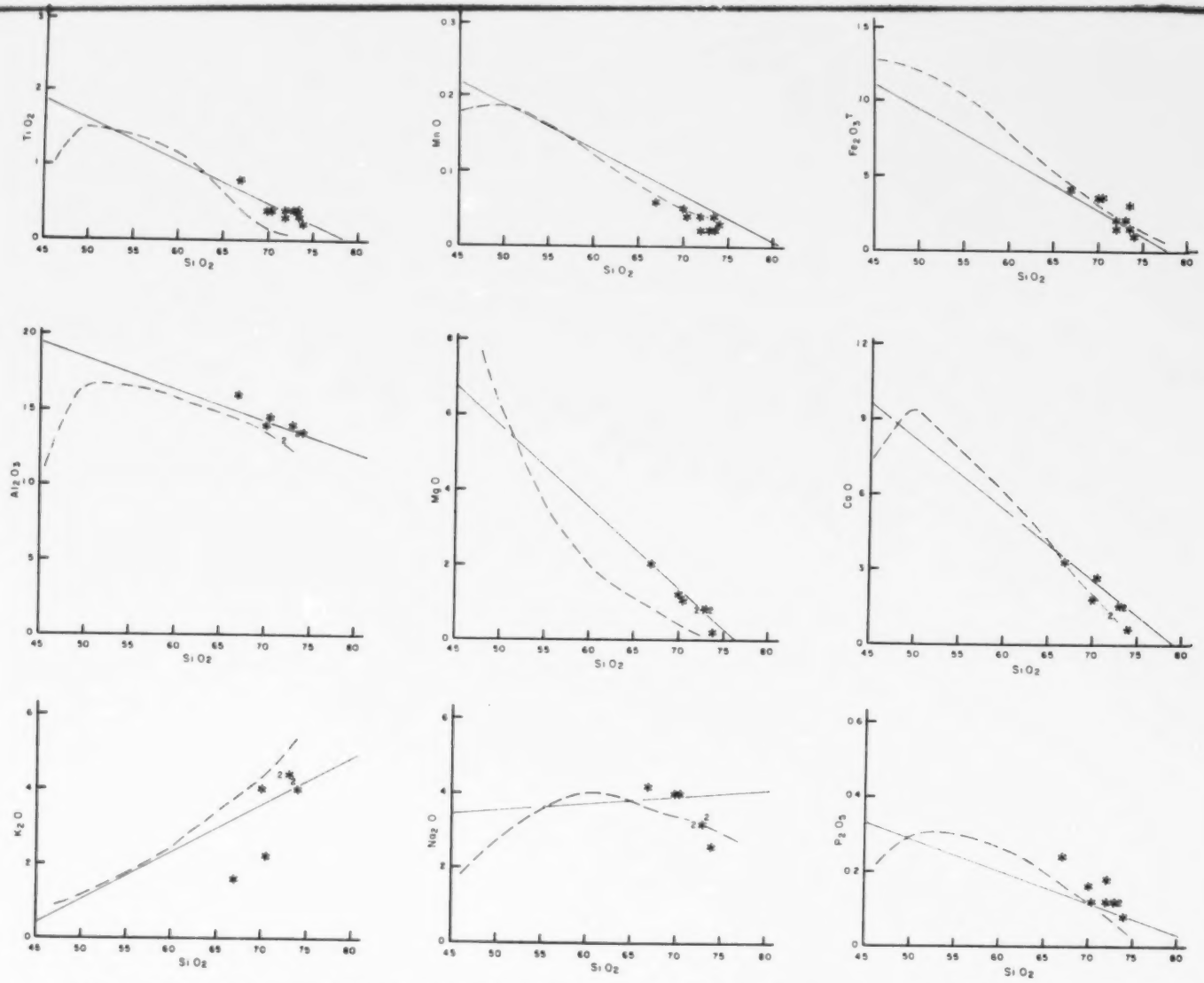


Figure 8-3. Silica variation diagrams for major element oxides in the Deep Cove pluton. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

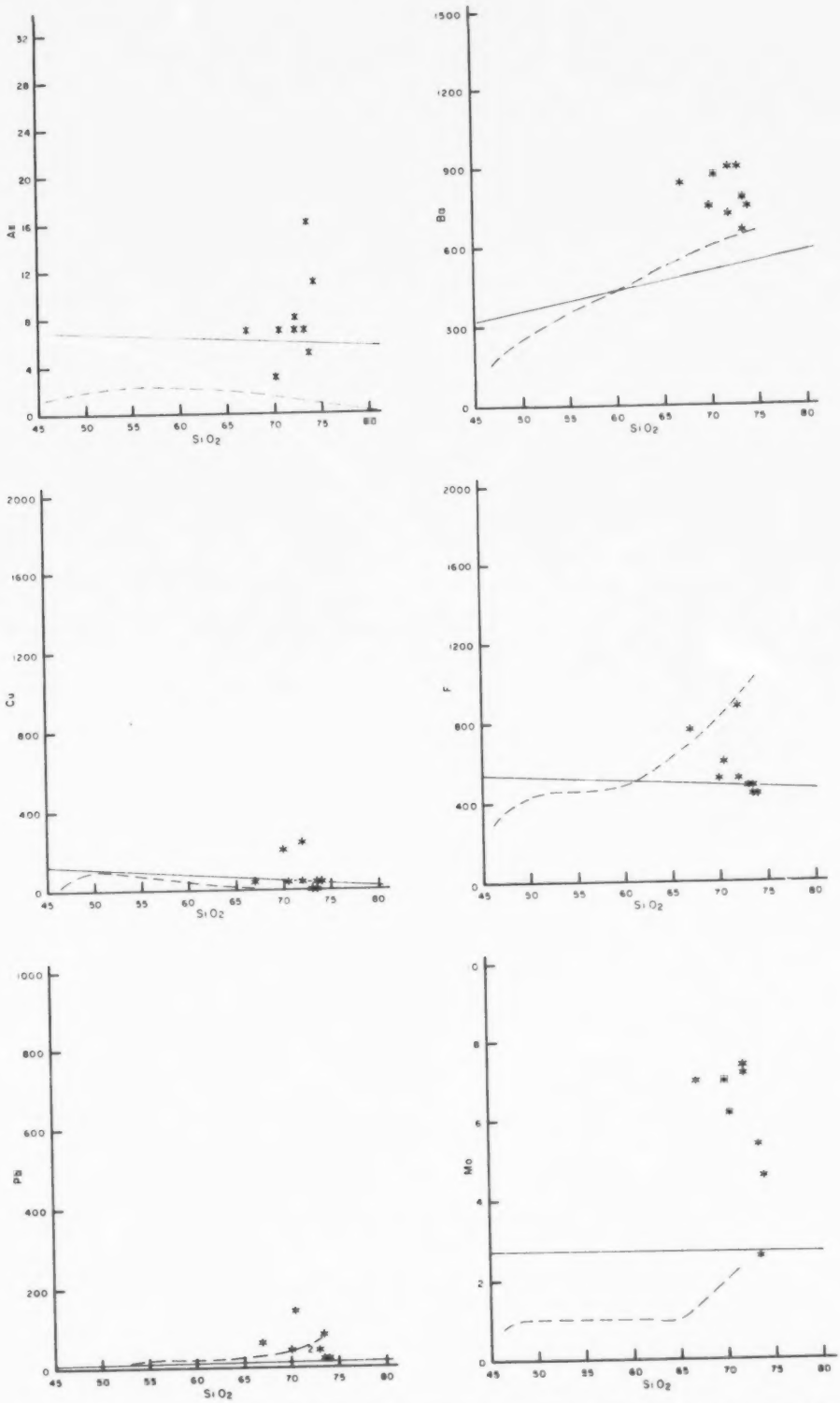


Figure 8-4. Silica variation diagrams for trace elements in the Deep Cove pluton. Lines as in Figure 8-3.

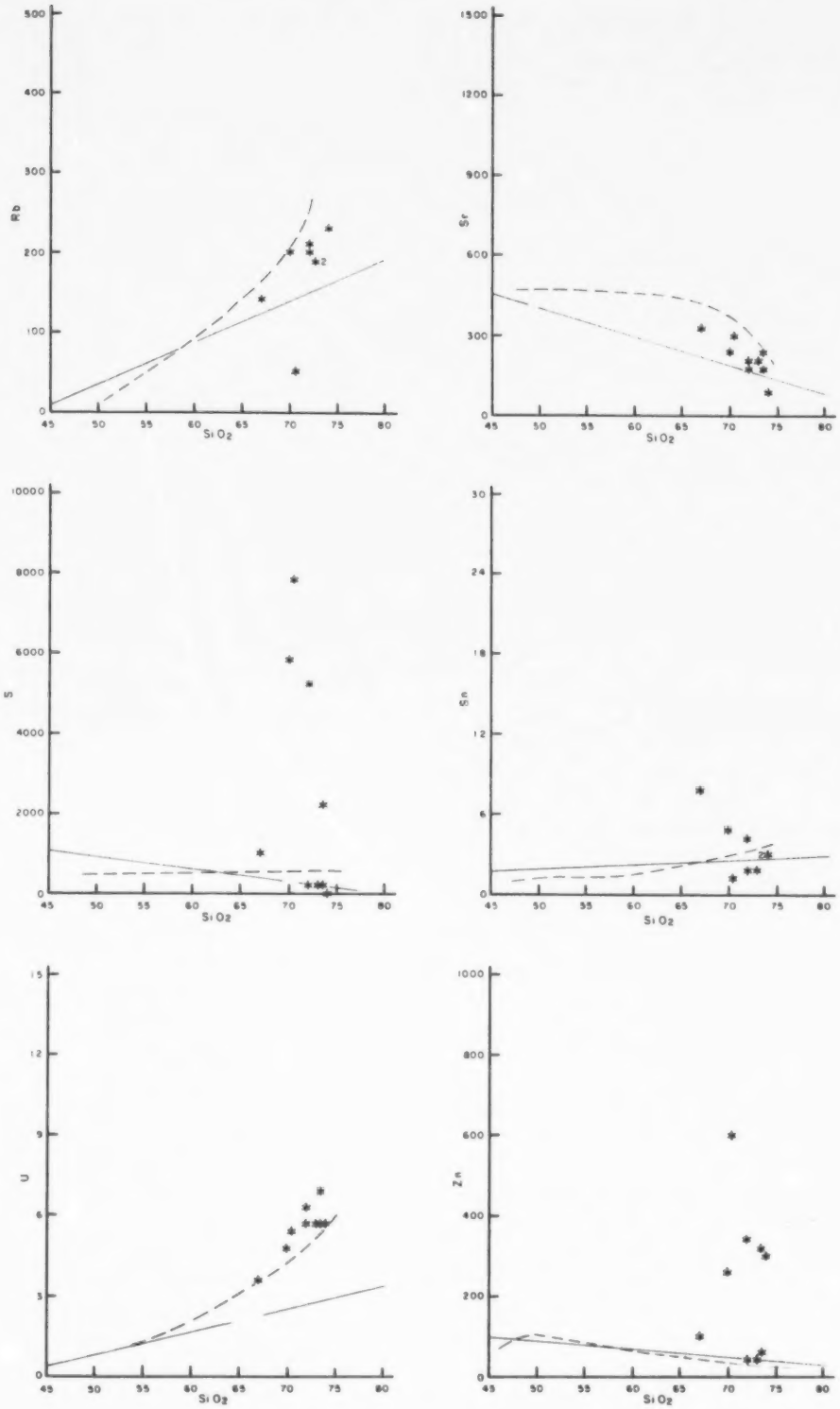


Figure 8-4. Continued.

the mineralization revealed by recent exploration activity is beyond the scope of this report, but is described in various assessment files of the Nova Scotia Department of Mines and Energy and by Macdonald (in preparation).

AGE

Cormier (1972) obtained an age of 342 ± 25 Ma (Keppie and Smith, 1978) from a whole-rock and biotite Rb/Sr isochron based on a single sample from the Deep Cove pluton. The new age of 384 ± 10 Ma obtained from Gillis Mountain pluton suggests that the age of the Deep Cove pluton is likely to be older than 342 ± 25 Ma. An isochron age based on one sample is not very reliable, and the two plutons have many similarities.

SUMMARY

The Deep Cove pluton is a small, mineralized granitic body of probable Devonian age which, with associated dykes, intruded the Fourchu Group in southeastern Cape Breton Island. In petrology it is comparable to the nearby Gillis Mountain pluton, with which it was probably comagmatic.

CHAPTER 9
PETIT-DE-GRAT PLUTON

INTRODUCTION

LOCATION AND ACCESS

The Petit-de-Grat pluton is a small body of granitoid rocks located on the southeastern coast of Petit-de-Grat Island in southeastern Cape Breton Island (Figs. 1-1 and 9-1). Access to the pluton is by Route 206 to the village of Petit-de-Grat. The road terminates at the northern edge of the pluton. Several footpaths cross the pluton.

SIZE AND EXPOSURE

The pluton is inferred to be approximately equidimensional and 0.6 km^2 in area. Exposure is excellent along the rocky coastal section, but nonexistent in the swampy area inland.

PREVIOUS WORK

Weeks (1954) described the Petit-de-Grat pluton as a small body of rhyolite intruding pre-Horton volcanic rocks (Fourchu?). No petrologic or chemical studies have been previously carried out on the pluton.

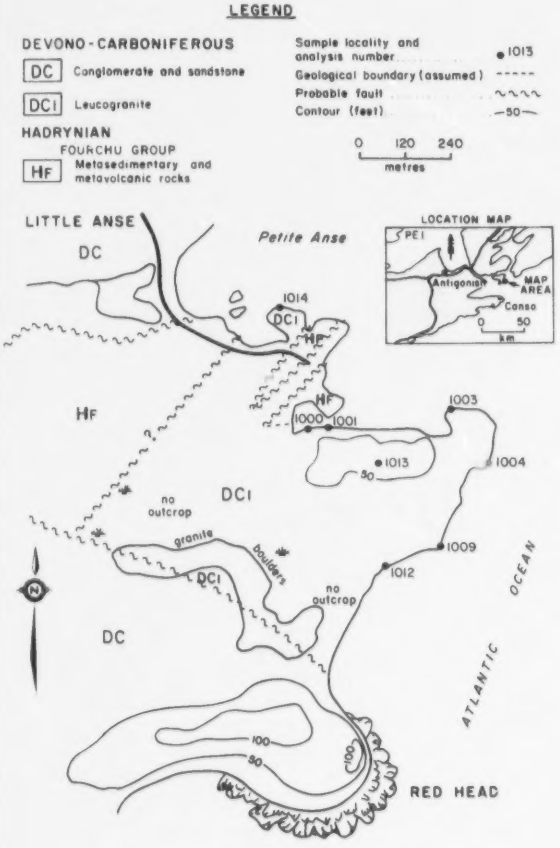


Figure 9-1. Geology of the Petit-de-Grat pluton.

GEOLOGICAL SETTING

The Petit-de-Grat pluton has intruded metaconglomerate and other metasedimentary rocks of the Fourchu Group. This is based on the presence of abundant xenoliths within the pluton, as exposed contacts are generally faulted. The pluton is overlain by conglomerates (containing fragments of the plutonic rocks) and sandstones of the Horton Group. Contacts are not exposed.

PLUTONIC ROCKS

FIELD RELATIONS

The Petit-de-Grat pluton is composed of homogeneous medium- to coarse-grained pink leucogranite. It is intensely and pervasively fractured, with secondary epidote and hematite present along fractures. In places these are so closely spaced as to be termed fracture cleavage, trending 060° and essentially vertical. Dark fine grained xenoliths (metasedimentary?) are abundant. They show no evidence of assimilation, having sharp contacts with the leucogranite, which shows no increase in mafic mineral content adjacent to xenoliths.

The leucogranite is cut by rare aplite dykes and contains abundant pegmatoid and vuggy patches.

PETROGRAPHY

In thin section all samples from the Petit-de-Grat pluton exhibit intense cataclastic texture. Porphyroclasts of deformed quartz and feldspar are set in a matrix of granulated quartz and feldspar. Perthitic orthoclase comprises approximately 60 per cent of the rock, albitic plagioclase 15 per cent, and quartz 25 per cent. Minor chlorite (<1%) is presumably secondary after biotite. Samples show little petrographic variation (Fig. 9-2a, Appendix C).

GEOCHEMISTRY

Major Element Geochemistry

The average analysis of eight samples from the Petit-de-Grat pluton is presented in Table 9-1 and the analytical data are displayed on silica variation diagrams (Fig. 9-3). As indicated by the petrography, the leucogranite is relatively homogeneous and extremely felsic. Only SiO_2, K_2O, and Na_2O are present in appreciable amounts.

On the plot of normative Q-Or-Ab+An the samples lie in the right area of the granite field (Fig. 9-2b) due to the inclusion of albite component with plagioclase. In fact, appreciable Na is contained in the modal orthoclase (unpublished electron microprobe data).

Trace Element Geochemistry

Average trace element data for the Petit-de-Grat pluton are presented in Table 9-1 and all data are displayed on variation diagrams (Fig. 9-4) together with linear regression lines for selected plutons of this study (see Chapter 1) and average calc-alkalic plutonic rocks (Gribble, 1969). The main features are discussed below.

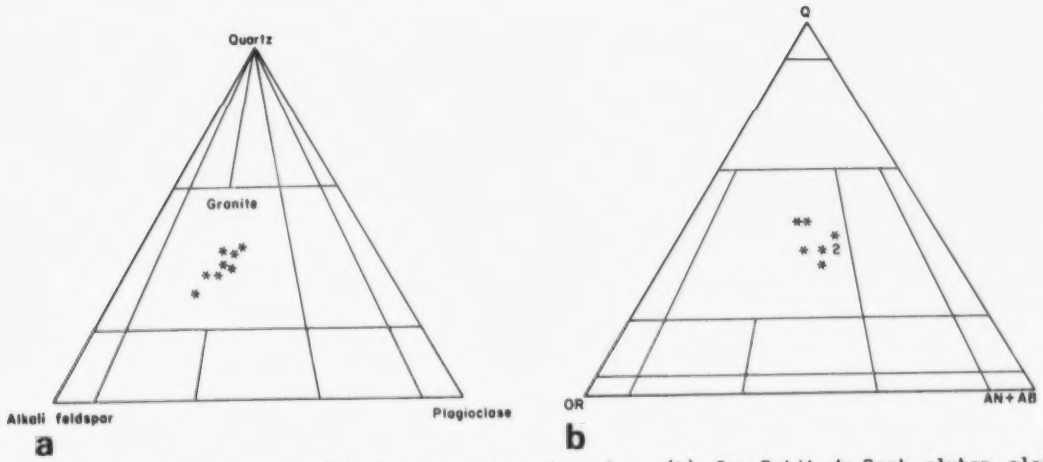


Figure 9-2. Modal mineralogy (a) and normative mineralogy (b) for Petit-de-Grat pluton plotted on the ternary diagram of Streckeisen (1976). Q = normative quartz; OR = normative orthoclase; AN + AB = normative anorthite plus ablite.

Arsenic values are similar to those in other plutons in this study, higher than those suggested by Gribble (1969) for calc-alkalic rocks. They show considerable variation compared to most other elements in this pluton.

Barium values are low compared to other plutons, but similar in all eight samples. The low values are consistent with the sharp decrease in Ba in rocks containing more than 75 per cent SiO_2 shown by Gribble (1969).

Copper contents are low, with little variation beyond analytical error at these low concentrations.

Fluorine values are also extremely low, especially in comparison to other leucogranites of this study, and levels depicted by Gribble (1969).

Lead values are uniformly low.

Molybdenum values are low and similar to those in other leucogranites of this study.

Rubidium displays a range of values similar to other leucogranites of this study.

Strontium contents are low and uniform, and similar to those in other granites in Cape Breton Island.

Sulphur contents are also low.

Tin values are low and uniform.

Uranium values are varied and somewhat high even for felsic rocks.

Zinc values are low and uniform.

ECONOMIC GEOLOGY

No economic mineralization is known to be present in the Petit-de-Grat pluton. Silvery-grey hematite crystals are apparent on some fracture surfaces.

Table 9-1. Average analyses and standard deviations for samples from the Petit-de-Grat pluton.

	Leucogranite (n = 8)	
SiO_2	77.84 ±	1.54
TiO_2	0.10	0.01
Al_2O_3	11.36	0.50
Fe_2O_3T	0.74	0.05
MnO	0.01	<0.01
MgO	0.09	0.03
CaO	0.70	0.07
K_2O	4.47	0.51
Na_2O	3.64	0.70
P_2O_5	0.01	0.01
As	9 ±	5
Ba	343	63
Cu	5	6
F	50	20
Pb	11	2
Mo	3	<1
Rb	243	86
Sr	46	7
S	80	90
Sn	5	<1
U	9	3
Zn	14	6

AGE

On the basis of field relations the pluton is younger than the Fourchu Group and older than the Carboniferous rocks in the area. Six samples from the pluton yielded an excellent Rb/Sr isochron indicating an age of 357 ± 11 Ma (Carboniferous) (Cormier, 1980).

SUMMARY

The Petit-de-Grat pluton is a small, apparently unmineralized body of homogeneous leucogranite which has suffered intense and pervasive cataclasis. An apparent Carboniferous age may be the result of up-dating as a result of this deformation.

The leucogranite is extremely felsic. Major and trace element abundances are generally consistent with those expected of a felsic granite with the exception of As, F, and U which show somewhat anomalous features.

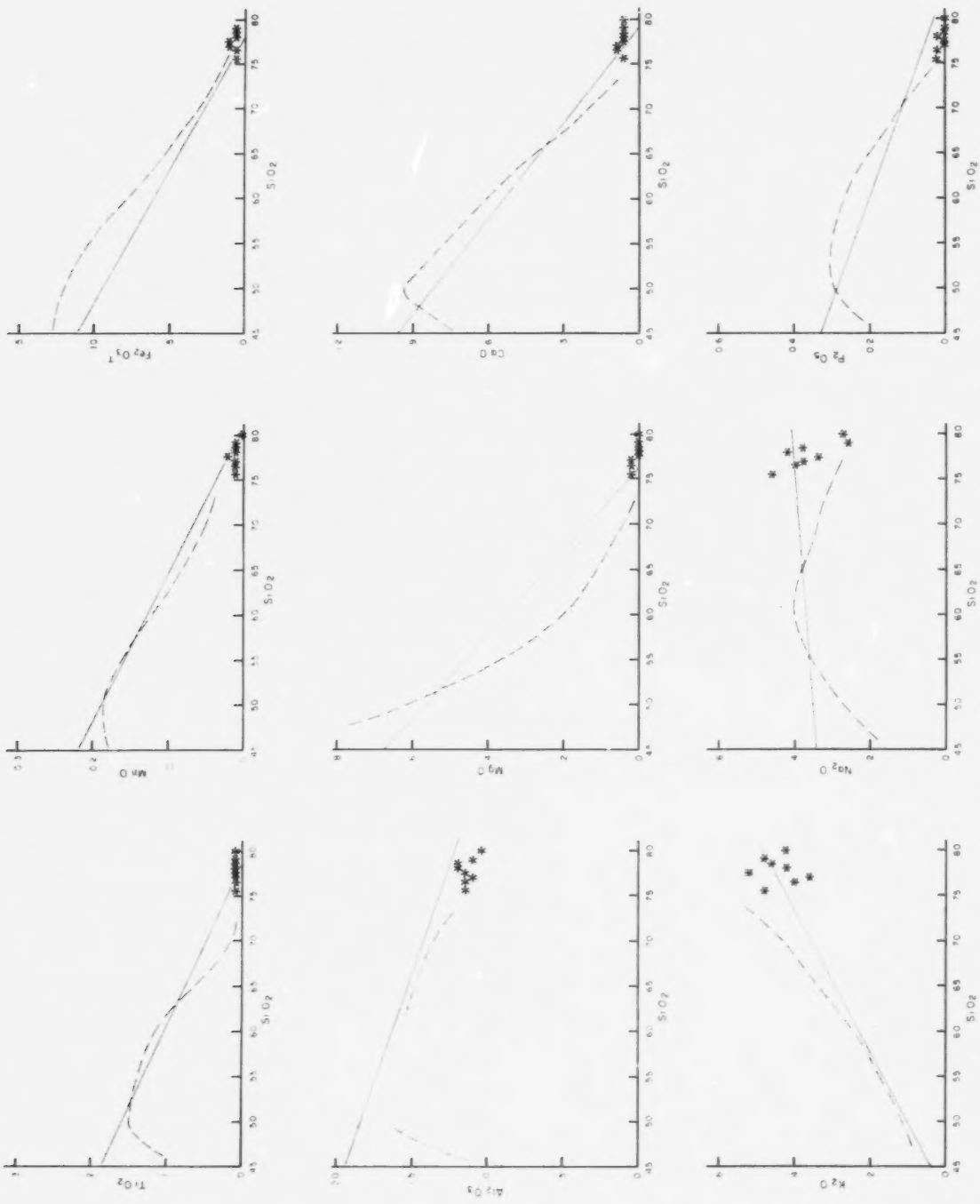


Figure 9-3. Silica variation diagrams for major element oxides in the Petit-de-Grat pluton. Solid lines are linear regression lines for data from selected plutons of this study (see Table 1-1). Dashed lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

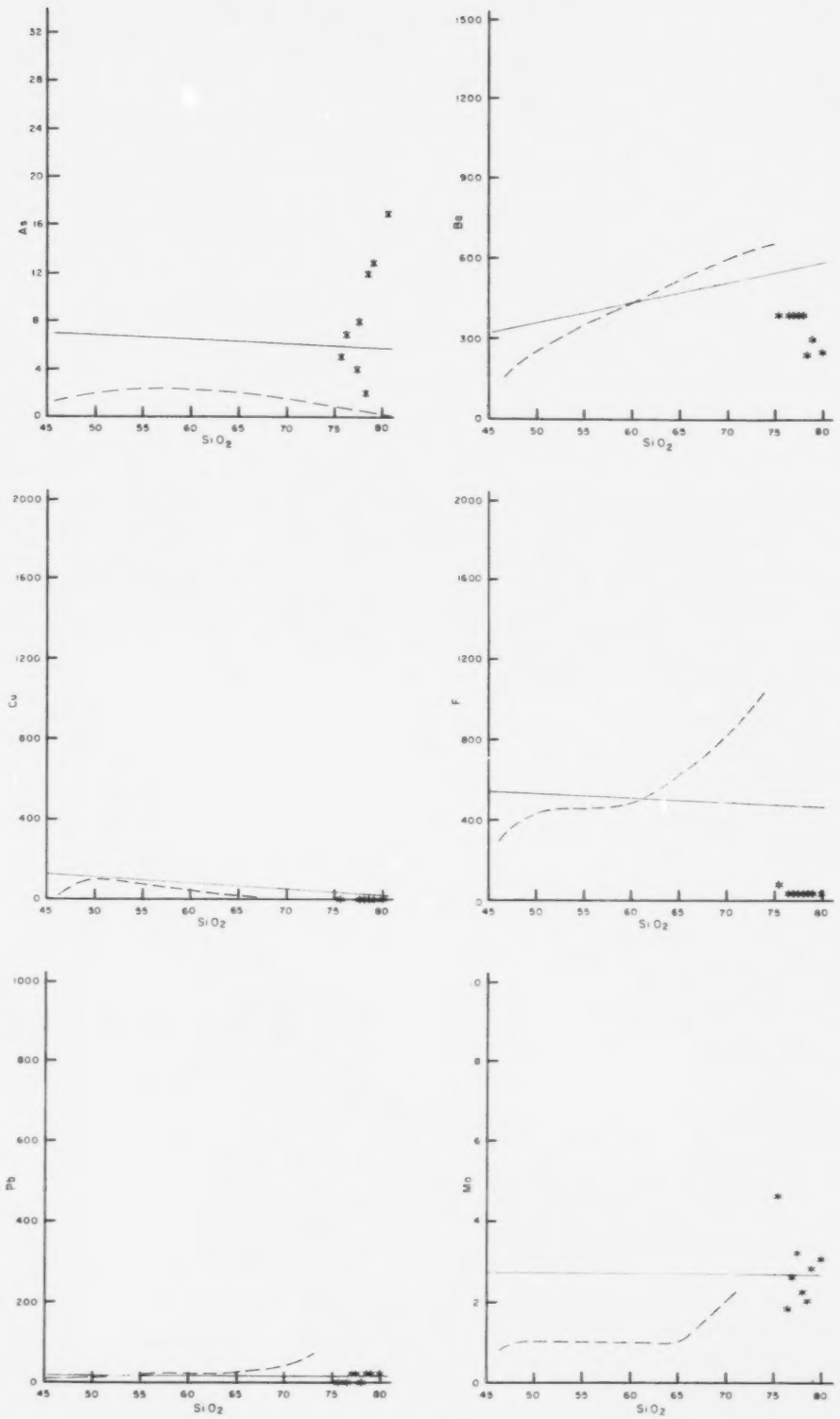


Figure 9-4. Silica variation diagrams for trace elements in the Petit-de-Grat pluton. Lines as in Figure 9-3.

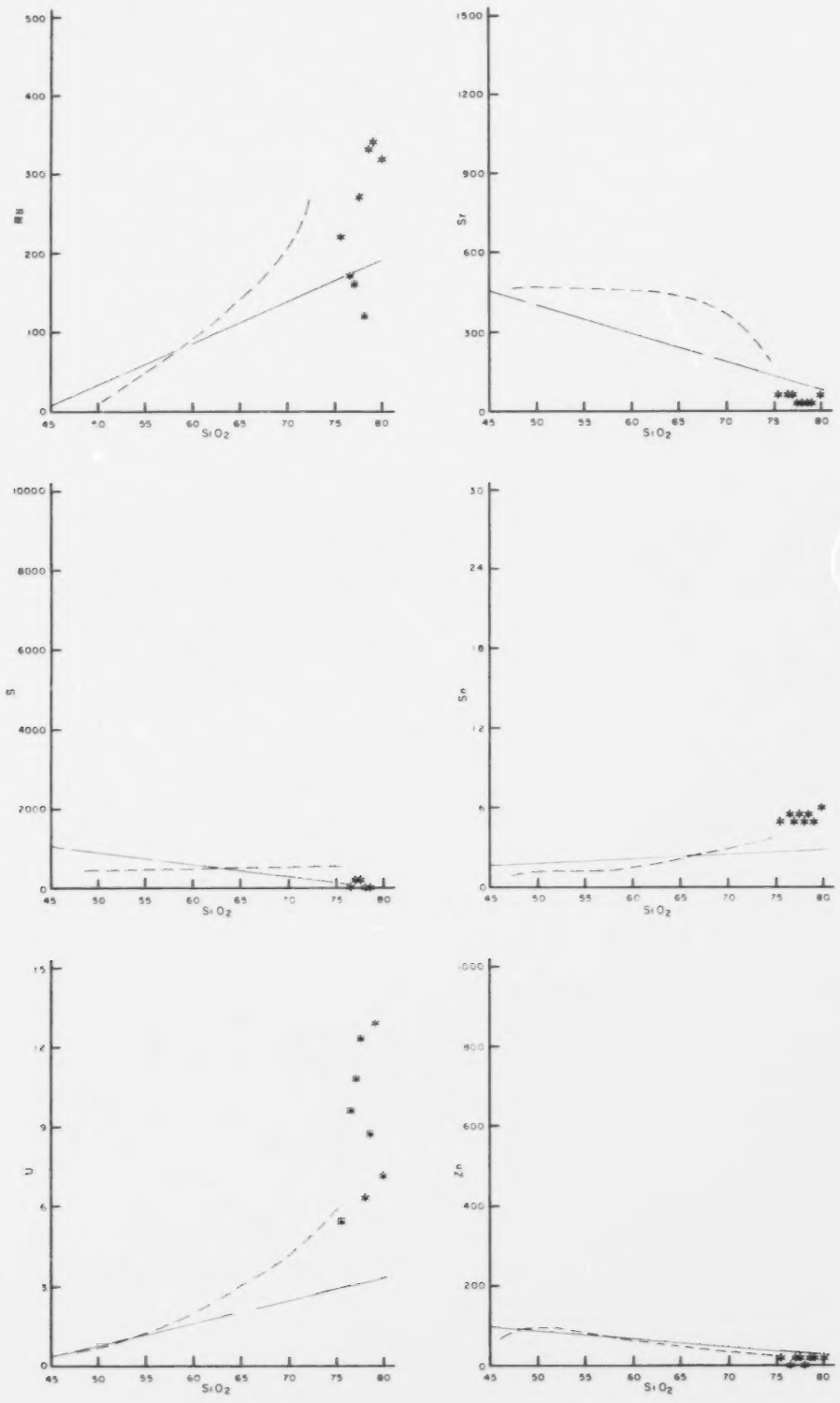


Figure 9-4. Continued.

CHAPTER 10
ADDITIONAL TRACE ELEMENT GEOCHEMISTRY

INTRODUCTION

Selected representative samples from the six main plutons and Deep Cove were analyzed for Sb, B, Be, Bi, Cd, Co, Li, Nb, Ni, Y, and Zr in addition to the major and trace element analyses already described. These samples were selected on the basis of their petrography and major and trace element geochemistry to be representative of the main phases and subphases of the six plutons.

The purpose of these analyses was to enable an assessment of the potential usefulness of these elements in future studies of granitoid plutons in Cape Breton Island.

The analytical data are presented in Appendix E and displayed on silica variation diagrams in Figure 10-1. As the data are quite scattered, as well as varying with SiO_2 content, comparisons among plutons are not readily made. However, "granites" (containing more than 65% SiO_2) are present in all plutons, and a comparison of these rocks essentially removes the SiO_2 dependent variable. These data are presented in Table 10-1, and used in the discussions which follow.

DISCUSSION OF THE DATA

ANTIMONY

Antimony values are below the detection limit of 3 ppm (Appendix B) in all analyzed samples, and hence the usefulness of this element cannot be assessed.

BORON

Boron values show considerable scatter superimposed on a weak negative correlation with SiO_2 (Fig. 10-1a). They range from a high of 110 ppm in a sample from the dioritic complex of Kellys Mountain pluton to a low of 3 ppm in the felsic phases of several plutons. The felsic phases in general contain less B than average plutonic rocks of that silica range (Gribble, 1969) and there do not appear to be any significant differences among the plutons.

BERYLLIUM

Beryllium displays a weak positive correlation with SiO_2 and fairly uniform values of 2 to 5 ppm in all plutons except White Point (Fig. 10-1b). The granitic samples from the White Point pluton contain up to 9 ppm Be, with a high value of 17 ppm in the aplite sample. These abundances are generally more consistent with those for other calc-alkalic plutonic rocks (Gribble, 1969) than are those in the other granitic rocks of Cape Breton Island (Fig. 10-1b).

BISMUTH

Bismuth values show considerable range, especially in the felsic phases. The highest value is in the granite from Deep Cove (1.7 ppm), a pluton which has associated Cu-Mo-Bi mineralization. Gillis Mountain samples, with one exception, do not show anomalous Bi values. Most Bi values are lower than the average trend from Gribble (1969) (Fig. 10-1c).

CADMIUM

Cadmium values are below the detection limit of 0.5 ppm (Appendix B) in all analyzed samples, and hence the usefulness of this element cannot be assessed.

COBALT

Cobalt shows a strong negative correlation with SiO_2 in all plutons, and the abundances are very similar to those reported by Gribble (1969) (Fig. 10-1d).

LITHIUM

Lithium values show considerable scatter and no correlation with SiO_2. Like Be, Li contents are highest in the White Point pluton. The values scatter around the average trend line from Gribble (1969) (Fig. 10-1e).

NICKEL

Nickel shows a typical negative correlation with SiO_2 although there is wide scatter in the values (Fig 10-1f). None of the plutons shows consistent anomalous patterns although samples from Gillis Mountain pluton tend to contain higher Ni than those from other plutons (Table 10-1).

NIOBIUM

Niobium is below the detection limit of 100 ppm (Appendix B) in all analyzed samples. Because of this high detection limit, the usefulness of Nb cannot be assessed.

Table 10-1. Average selected trace element data for samples containing more than 65% SiO_2 (ie. "granites").

Pluton n	Huntington Mtn. 8		Kellys Mtn. 14		St. Anns Mtn. 6		Cape Smoky 7		White Point 13		Gillis Mtn/ Deep Cove 8	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
B	5	2	9	3	6	3	7	2	5	2	7	2
Be	4	2	4	1	4	1	3	1	7	3	3	1
Bi	0.13	0.05	0.11	0.19	0.04	0.04	0.10	0.02	0.16	0.16	0.4	0.6
Co	3	2	2	0.8	4	4	3	4	3	2	5	3
Li	5	2	23	11	23	4	19	11	62	22	31	6
Ni	4	6	3	2	3	2	2	2	4	3	9	3
Y	32	8	28	12	46	23	14	13	14	19	34	16
Zr	264	64	254	112	252	29	199	112	170	39	222	59

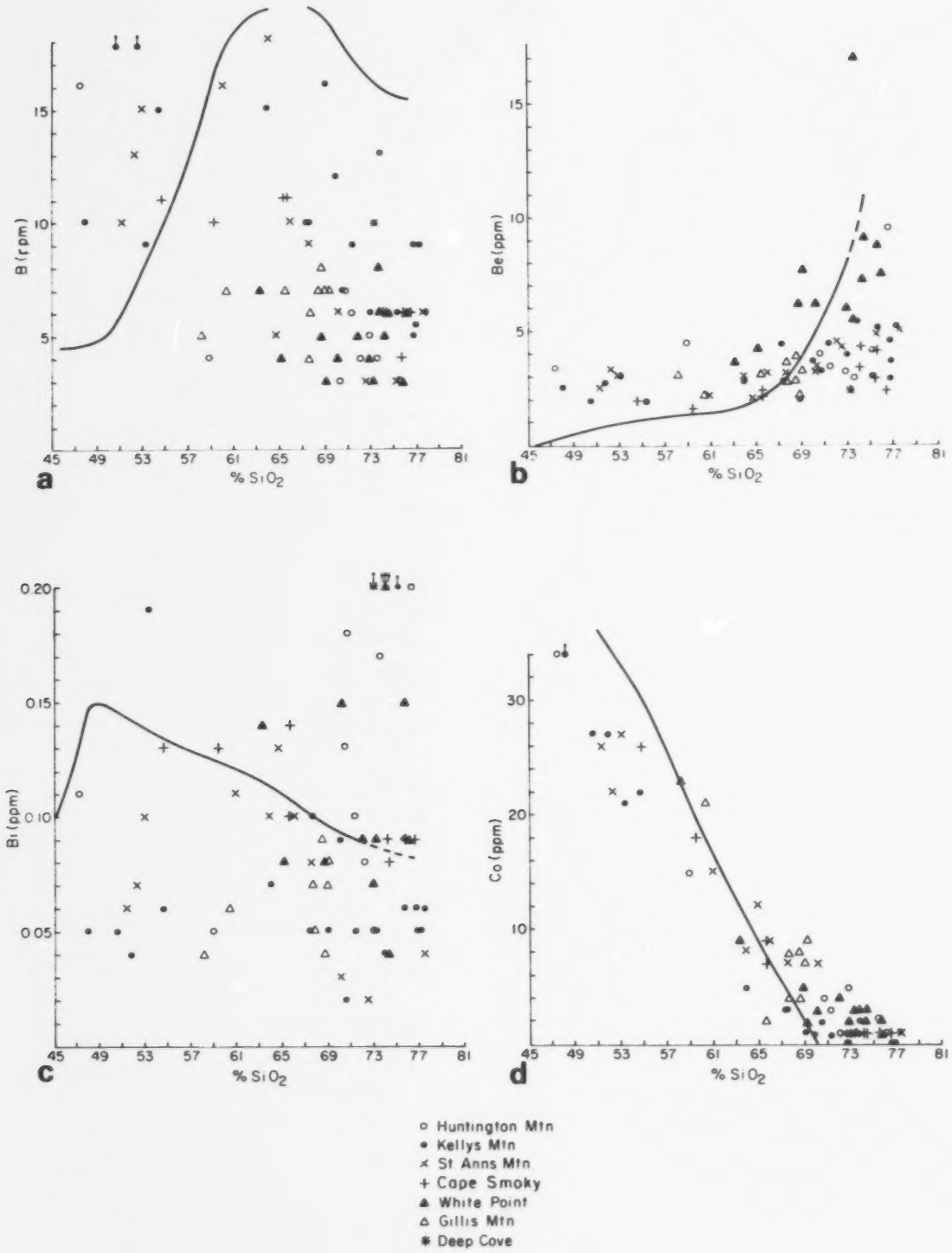


Figure 10-1. Silica variation diagrams for B, Be, Bi, Co, Li, Ni, Y, and Zr. Symbols as shown. Lines are average trends for calc-alkalic plutonic rocks from Gribble (1969).

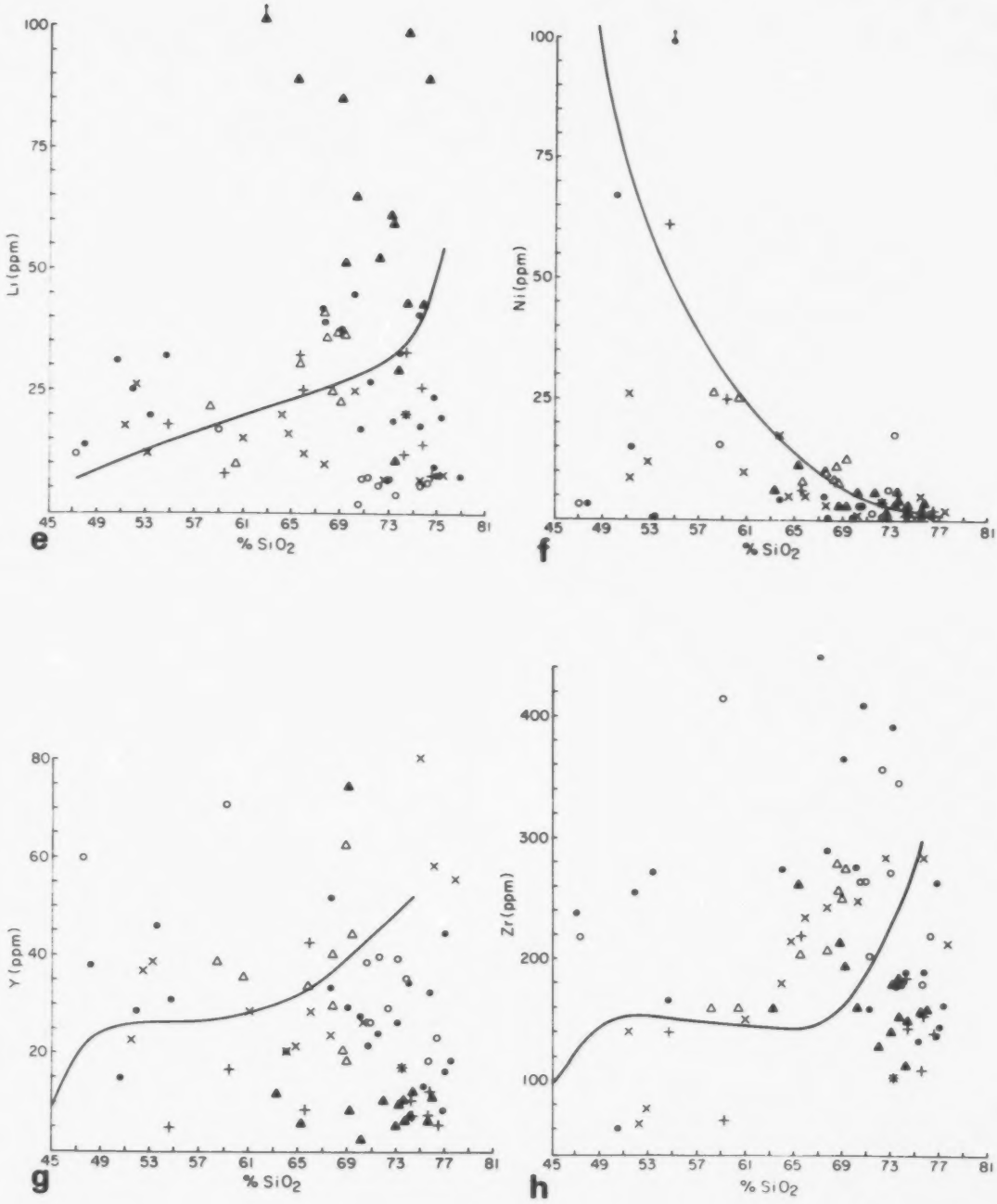


Figure 10-1. Continued.

YTTRIUM

Yttrium shows wide scatter and no correlation with SiO_2. None of the plutons seems to show distinctive patterns in Y contents, although values in the White Point and Cape Smoky plutons are especially low (Fig. 10-1g).

ZIRCONIUM

Zirconium shows very weak positive correlation with SiO_2, although many felsic samples, especially those from Cape Smoky and White Point plutons, contain low amounts of Zr.

CONCLUSIONS

Antimony and cadmium do not appear to have practical potential as indicator elements because they are present in very low concentrations in all plutons. Niobium was not adequately assessed because of the high detection limit of the analytical method available. Other methods which could be done at CLIM Laboratory are prohibitively expensive for routine work.

The plutons of this study have more or less normal abundances and patterns for the other eight elements, on the basis of comparison with the average trends of Gribble (1969). The variations which occur within and between plutons are generally small, and the number of analyses insufficient to assess their statistical validity. Only Ni shows anomalous abundances in the Gillis Mountain pluton, whereas the high Bi value in the one sample from Deep Cove correlates with the occurrence of Bi mineralization in that pluton. Other patterns include high Be and Li, and low B, Y, and Zr in the White Point pluton and low Y and Zr in the Cape Smoky pluton. The significance of these differences is not known at present.

In conclusion, these admittedly limited data do not suggest that these additional trace elements provide information substantially different from the other elements previously described. They confirm the distinctive petrology of the White Point pluton, but with the possible exception of Ni, do not appear to be sensitive to the presence of mineralizaton at Gillis Mountain.

CHAPTER 11
SYNTHESIS

AGE AND FIELD RELATIONS

On the basis of radiometric age dating (Cormier, 1972, 1979, 1980), the plutons of this study fall into three age groups:

(1) Late Hadrynian-Cambrian (600-500 Ma); including Huntington Mountain, Kellys Mountain, and St. Anns Mountain plutons.
(2) Ordovician-Silurian (?); Cape Smoky pluton.
(3) Devono-Carboniferous; White Point, Gillis Mountain, Deep Cove, and Petit-de-Grat plutons.

Plutons of the first group, like other plutons of similar age in Cape Breton Island, are generally elongate northeast-southwest, parallel to regional structural trends. The Cape Smoky pluton is also part of this regional trend, and the apparent lack of other plutons of Ordovician age in Cape Breton Island has led to the suggestion that the Cape Smoky pluton may actually be of Late Precambrian-Cambrian age (J. D. Keppie, personal communication, 1980). However, the petrology of this pluton is rather distinctive (see next section), and hence, inclusion with the older plutons does not seem justified. Additional mapping in northern Cape Breton Island is obviously required in order to understand the intrusive history.

Plutons of the younger group are not elongate in this northeast-southwest regional trend, although foliation in the White Point pluton tends to lie in that orientation (Fig. 6-1). The White Point pluton was syntectonic, presumably with the Acadian Orogeny, and is part of a much larger plutonic complex of similar character (Wiebe, 1972, 1975). In contrast the Gillis Mountain and Deep Cove plutons are very small, unfoliated, distinctly discordant, and post-tectonic. The small Petit-de-Grat pluton appears to have been tectonically emplaced along faults trending approximately east-west (Fig. 9-1 and Keppie, 1979).

PETROGRAPHY

The plutons of Late Hadrynian-Cambrian age (Huntington Mountain, Kellys Mountain, and St. Anns Mountain) are similar in lithology. Their oldest phases are dioritic complexes consisting of rocks which range from mafic diorite through quartz diorite, tonalite, granodiorite, and quartz monzonite. The mineralogies of these rocks are typical of plutonic rocks of their compositional range (mafic to intermediate), consisting primarily of andesine and hornblende. Pyroxene is rarely present even in mafic diorites, but biotite appears in granodiorites and quartz monzonites. Textures are generally distinctly ophitic or subophitic, with quartz (if present) occurring as interstitial anhedra. Sphene is commonly present as unusually large and abundant subhedral crystals.

The dioritic rocks have been intruded by pink leucogranite and associated subphases which far exceed them in volume. These felsic rocks are characterized by abundant quartz (commonly 40% to 50%) and more plagioclase (oligoclase) relative to alkali feldspar (orthoclase) than is typical of such felsic rocks. They would be classified as monzogranite in the subdivision of the granite field suggested by Streckeisen (1976). They contain distinctive perthitic orthoclase and small amounts of biotite (generally altered to chlorite). Amphibole is not present. Fine grained aplitic areas and dykes in which graphic textures are typical are associated with the leucogranite.

St. Anns Mountain pluton differs somewhat from Kellys Mountain and Huntington Mountain plutons in that the dioritic rocks are more commonly granodioritic and extensively altered in places. Bodies of granodiorite with Cu-Mo mineralization are gradational with the leucogranite. This variant may be present on Kellys Mountain and Huntington Mountain as biotite granite or porphyritic quartz monzonite, but without mineralization.

In addition St. Anns Mountain pluton includes minor younger dioritic and monzonitic bodies which are apparently absent from the other plutons.

The Cape Smoky pluton differs in important petrographic aspects from the Precambrian-Cambrian plutons. Older dioritic rocks of two different ages have been intruded by the biotite granite of the Cape Smoky pluton. The younger of these (Ingonish River pluton of Wiebe, 1972) may be equivalent to the dioritic complexes of the Precambrian-Cambrian plutons, but the older "dioritic complex" (Fig. 5-1) is considered more likely to be correlative.

The pink biotite granite of the Cape Smoky pluton is quite different from the leucogranites of the Precambrian-Cambrian plutons. Although it is also rich in quartz and oligoclase, the alkali feldspar is microcline. Biotite comprises 5 to 15 per cent of the rock, although some areas grade to leucogranite. The rocks exhibit evidence of considerable deformation, which is lacking in the other plutons.

The White Point pluton is petrographically distinct from all others in this study. It consists of relatively homogeneous medium grained equigranular granite (with gradations to granodiorite) characterized by abundant quartz, oligoclase, microcline, and both muscovite and biotite. Myrmekitic intergrowths are virtually ubiquitous in the groundmass. Pegmatites and aplites form extremely abundant dykes. Foliation in the granite indicates syntectonic crystallization. The pluton is part of a larger plutonic complex of similar petrography (Wiebe, 1972, 1975).

The Gillis Mountain pluton is also distinctive, forming a composite body of three main phases. The oldest is quartz monzodiorite, characterized by abundant hornblende (± pyroxene or biotite). Two granitic phases are present, the older porphyritic with plagioclase phenocrysts and the younger fine grained and equigranular.

Co-existing amphibole and biotite are characteristic of both. The alkali feldspar in all three phases appears to be sanidine. Cu-Mo mineralization occurs in all three rock types, as well as in later minor phases (aplites, porphyries). The pluton has a well developed contact metamorphic aureole, and was apparently emplaced at shallow (subvolcanic) depth.

The Deep Cove pluton has petrographic similarities to the granitic phases of Gillis Mountain, and is probably comagmatic, connected at depth to the same magma source (see geochemistry section below).

Petit-de-Grat pluton is composed of another distinctive granitic type, being virtually devoid of mafic minerals. It is extremely sheared and characterized by cataclastic textures, with no relict igneous texture preserved. It has probably been tectonically emplaced into its present setting.

MAJOR ELEMENT GEOCHEMISTRY

The plutons are remarkably consistent in major element geochemistry. This is illustrated by a series of silica variation diagrams on which the fields for analyzed samples from each of the plutons are outlined (Fig. 11-1). Fields for Gillis Mountain and Deep Cove plutons have been shaded on these diagrams for clarity. They are the most intensely mineralized plutons. Although there is considerable spread in some of the fields, particularly in the dioritic rocks, few significant differences appear between plutons in rocks of similar silica contents. Interesting exceptions to this generality occur on the plots for TiO_2, Fe_2O_3T, and P_2O_5, on which there is a suggestion that samples from Gillis Mountain may have somewhat higher contents of these oxides in rocks of intermediate silica contents.

The oxides show a negative correlation with SiO_2, with the exception of K_2O which shows a positive correlation and Na_2O which does not change significantly with SiO_2 content. Because of these correlations with SiO_2, chemical comparisons among plutons must take into account the SiO_2 contents of rocks being compared. For this purpose, the "granitic" phases containing more than 65% SiO_2 have been selected because at least one such phase is present in each of the plutons studied. The means and standard deviations of the major element oxides in these "granitic" phases are compiled in Figure 11-2.

Even within these "granites", SiO_2 and other major element oxides show considerable range, but correlations are apparent. Leucogranites, with relatively high SiO_2 contain relatively less TiO_2, Al_2O_3, Fe_2O_3T, MnO, MgO, and CaO, whereas more mafic granites with less SiO_2 generally show the opposite. The biotite granite of Cape Smoky pluton and the White Point granite are similar to the leucogranites although White Point granite is very low in MnO and MgO.

The St. Anns Mountain biotite quartz monzonite and the Gillis Mountain granites are lower in SiO_2, and correspondingly higher in TiO_2, Al_2O_3, Fe_2O_3T, MgO, and CaO. Deep Cove granites are somewhat more felsic than those of Gillis Mountian, and show wider variation. This may be because many samples are from dykes in the country rocks. The Petit-de-Grat pluton is the most felsic of all those studied.

TRACE ELEMENT GEOCHEMISTRY

To facilitate comparison, compilations of mean, standard deviation, range and coefficient of variation for each trace element in each major phase or subphase of the plutons are presented in Tables 11-1a to 11-1l. It should be remembered that some of these groupings (particularly the dioritic complexes) contain a variety of lithologies and hence the means and other statistical data are not really petrologically significant. Furthermore, many of the trace elements show log-normal distributions (see Chapter 12), and hence arithmetic means and related statistics are not, strictly speaking, accurate. However, given the small number of samples from most rock types, the errors introduced by this simplification are not large, and the data provide a convenient means of comparing plutons.

These data are displayed on silica variation diagrams where the mean and standard deviation in each rock type from Table 11-1 are plotted against the mean SiO_2 content of that rock type (Figs. 11-3a to 11-3l). These diagrams emphasize the interrelationship of trace element concentration and silica content, and illustrate the importance of comparing only rocks of comparable petrography. As for the major element oxides, it is important to compare only rocks of similar silica range. The means and standard deviations for "granitic" phases (containing more than 65% SiO_2) are shown in Figure 11-4. The main features displayed by each element are discussed below.

ARSENIC (Table 11-1a, Fig. 11-3a)

Analyses of standards for As indicate considerable uncertainty, especially for concentrations approaching 1 ppm (Appendix B). Hence the fact that mean As values in Cape Breton plutons are higher than those cited by Gribble (1969) (Fig. 11-3a) may not be significant, and the relatively large standard deviations and ranges may be the result of analytical uncertainty rather than petrological factors. Nevertheless, the data suggest that As does not vary significantly with silica content or from pluton to pluton in Cape Breton Island.

BARIUM (Table 11-1b, Fig. 11-3b)

Barium contents are extremely variable in all plutons. According to de Albuquerque (1971) and Nockolds and Allen (1953), Ba in many calc-alkalic rock series increases from mafic to intermediate rocks (granodiorites) and then decreases sharply in the granites, although this was not revealed by the data of Gribble (1969). This trend is fairly apparent for the Huntington, Kellys, St. Anns, Cape Smoky, and Petit-de-Grat plutons taken as a group, although there is a wide spread in Ba contents in granitic rocks of these plutons (Fig. 11-4). However, the Gillis Mountain and Deep Cove data do not fit well into this pattern; the Ba contents of all rock types being generally higher than those in rocks of

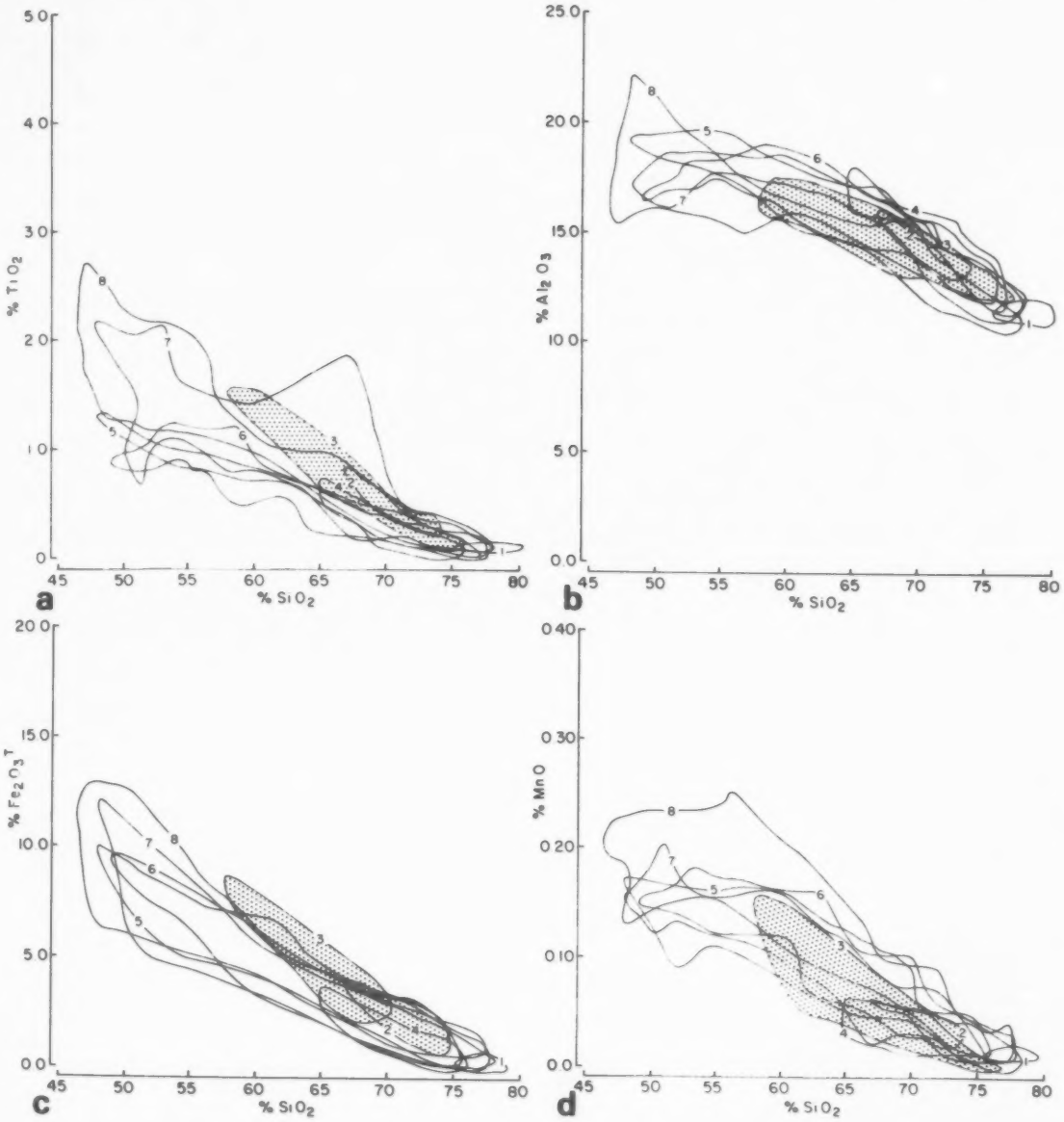


Figure 11-1. Summary silica variation diagrams for major element oxides in the plutons of this study. Each numbered field encompasses all data points for the pluton. Deep Cove - Gillis Mountain pluton fields are dotted for emphasis.

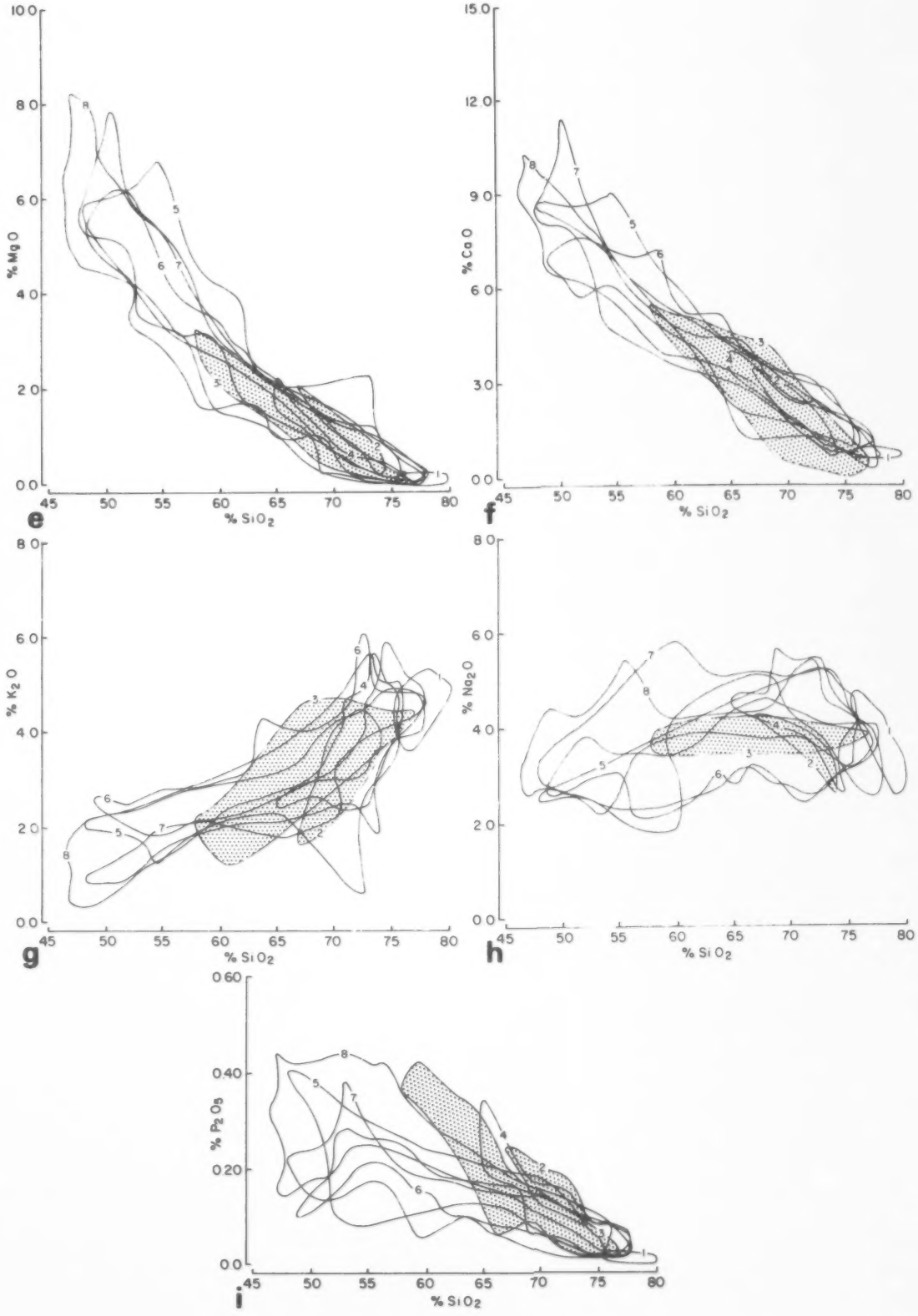


Figure 11-1. Continued.

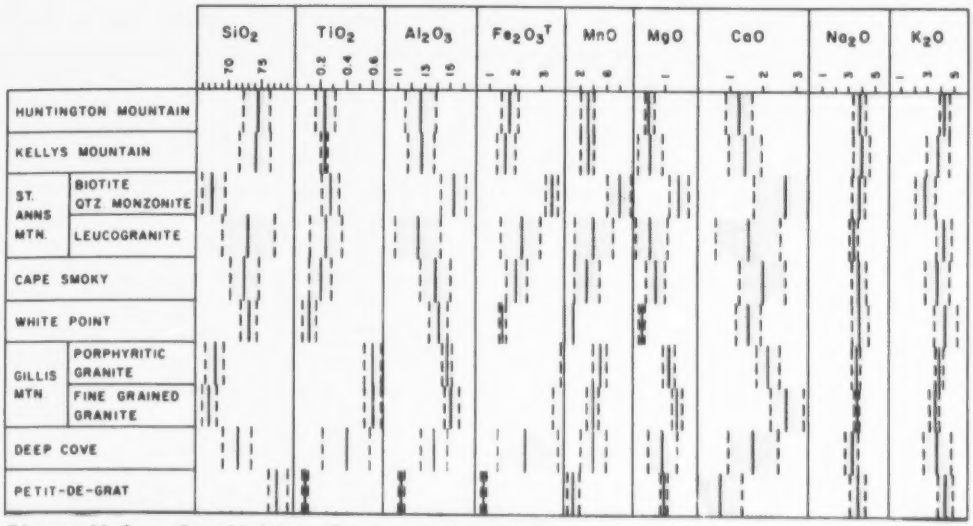


Figure 11-2. Compilation of means and standard deviations for major element oxides in the "granitic" phases of the plutons (those containing more than 65% SiO_2).

equivalent SiO_2 from other plutons (Fig. 11-3b, 11-4). A histogram of Ba values in the granitic phases displays the wide spread in Ba in the plutons, and clearly shows the concentration of high values in the Gillis Mountain-Deep Cove plutons (Fig. 11-5a). The two low samples are aplites in the Gillis Mountain pluton.

COPPER (Table 11-1c, Fig. 11-3c)

Copper contents in the Cape Breton plutons generally show a typical trend (Gribble, 1969), decreasing with increasing silica content. However, this pattern is not obvious in the Gillis Mountain-Deep Cove plutons due to the wide spread of Cu values. Within the St. Anns data, the negative correlation with silica is obvious, but Cu values are somewhat higher and more variable than in samples of similar silica contents from other plutons. Higher than normal means, standard deviations and coefficients of variation are obviously indicators of the occurrence of Cu mineralization in the Gillis Mountain-Deep Cove plutons and possibly in St. Anns. This is also evident in the comparison of the granitic rocks only (Figs. 11-4, 11-5b). "Granites" of St. Anns Mountain pluton have some high Cu values, and a larger range than the unmineralized plutons (Fig. 11-5b). However, large coefficients of variation (Table 11-1c) can also occur in granitic rocks where concentrations are close to the detection limit (i.e. a few ppm). These variations are probably the result of analytical uncertainties at such low concentrations.

FLUORINE (Table 11-1d, Fig. 11-3d)

Fluorine contents vary between about 300 and 1000 ppm and show a weak negative correlation with silica. This is in contrast to the trend given by Gribble (1969). In the granitic phases, F does not show wide variation (Fig. 11-4). Petit-de-Grat pluton is very low in fluorine.

LEAD (Table 11-1e, Figure 11-3e)

Lead values are uniformly low in Kellys, Cape Smoky, Huntington and Petit-de-Grat plutons, and show no trends with SiO_2. For no obvious petrographic reason, the White Point pluton contains higher Pb values than these other plutons. St. Anns data also tend to be somewhat higher and more variable, and Gillis Mountain and Deep Cove show wide spread, with some samples very high in Pb. In the latter two plutons at least, Pb is an indicator element for the presence of mineralization. This is also shown in a comparison of the granitic phases of the plutons (Figs. 11-4, 11-5c).

MOLYBDENUM (Table 11-1f, Fig. 11-3f)

Molybdenum values are very low in all plutons except Gillis Mountain and Deep Cove and show no trends with SiO_2. Gillis Mountain and Deep Cove samples are somewhat higher in Mo than those from other plutons, again a reflection of the presence of mineralization. This is also shown in a comparison of the granit samples (Figs. 11-4, 11-5d).

RUBIDIUM (Table 11-1g, Figure 11-3g)

Rubidium values generally increase with increasing SiO_2, although there is considerable scatter. Petit-de-Grat, Gillis Mountain, Deep Cove and White Point granites contain more Rb than granites from other plutons, although the values are not unusually high according to the data of Gribble (1969) (Figs. 11-4, 11-5e).

STRONTIUM (Table 11-1h, Figure 11-3h)

Strontium values are scattered, but show a generally negative correlation with SiO_2. All the plutons except White Point follow much the same pattern. The White Point samples show wide range

Table 11-1. Summary tables for trace element data for plutons in this study, showing mean, standard deviation, minimum and maximum values and coefficient of variation.

Table 11-1a. As

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	9	5	2	17	56
Deep Cove	9	Granite	8	4	3	16	50
Gillis Mountain	9	Quartz Monzodiorite	8	3	3	12	38
	28	Porphyritic Granite	7	3	2	12	43
	7	Fine grained Granite	5	2	2	8	40
White Point	5	Granodiorite	4	2	2	7	50
	34	Granite	7	3	1	16	43
Cape Smoky	7	Quartz Diorite, Granodiorite	7	5	2	16	71
	5	Granodiorite	8	4	2	14	50
	34	Biotite Granite	6	3	1	14	50
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	9	4	3	14	44
	11	Hbld. Biot. Granite, Granodiorite	8	5	2	17	63
	13	Biot. Granite, Leucogr.	9	4	4	17	44
	5	Qtz. Diorite, Granodior.	6	4	2	12	66
	4	Porph. Quartz Monzonite	9	5	4	16	56
Kellys Mountain	13	Dioritic Complex	7	3	3	13	43
	5	Biotite Granodiorite	7	4	4	14	57
	28	Leucogranite	6	2	3	12	33
	8	F.g. Granite, Aplite	6	4	3	14	66
Huntington Mountain	21	Dioritic Complex	6	3	3	18	50
	3	Porph. Quartz Monzonite	4	1	3	5	25
	17	Leucogranite, Graphic Granite	6	4	2	14	66

Table 11-1b. **Ba**

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	343	63	247	395	18
Deep Cove	9	Granite	798	88	670	915	11
Gillis Mountain	9	Quartz Monzodiorite	797	87	710	940	11
	28	Porphyritic Granite	882	112	720	1150	13
	7	Fine grained Granite	938	90	832	1083	10
White Point	5	Granodiorite	739	255	358	1030	35
	34	Granite	463	264	22	1010	57
Cape Smoky	7	Quartz Diorite, Granodiorite	280	102	182	446	36
	5	Granodiorite	599	150	363	770	25
	34	Biotite Granite	618	303	88	1330	49
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	415	127	110	600	31
	11	Hbld. Biot. Granite, Granodiorite	427	87	292	605	21
	13	Biot. Granite, Leucogr.	468	185	156	800	40
	5	Qtz. Diorite, Granodior.	512	155	280	700	30
	4	Porph. Quartz Monzonite	509	92	400	625	18
Kellys Mountain	13	Dioritic Complex	373	140	136	570	38
	5	Biotite Granodiorite	389	200	58	590	52
	28	Leucogranite	485	268	31	1300	55
	8	F.g. Granite, Aplite	277	227	20	570	82
Huntington Mountain	21	Dioritic Complex	412	261	87	1000	63
	3	Porph. Quartz Monzonite	872	115	740	945	13
	17	Leucogranite, Graphic Granite	632	296	234	1350	47

Table 11-1c. **Cu**

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	5	6	1	15	122
Deep Cove	9	Granite	73	85	12	251	116
Gillis Mountain	9	Quartz Monzodiorite	168	197	28	630	117
	28	Porphyritic Granite	202	556	13	3000	276
	7	Fine grained Granite	85	115	23	344	137
White Point	5	Granodiorite	7	6	1	17	84
	34	Granite	4	10	1	47	231
Cape Smoky	7	Quartz Diorite, Granodiorite	43	33	5	79	76
	5	Granodiorite	15	10	1	24	69
	34	Biotite Granite	6	6	1	27	107
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	67	46	14	143	68
	11	Hbld. Biot. Granite, Granodiorite	48	114	2	388	236
	13	Biot. Granite, Leucogr.	14	26	1	100	26
	5	Qtz. Diorite, Granodior.	62	27	26	85	44
	4	Porph. Quartz Monzonite	20	12	6	31	62
Kellys Mountain	13	Dioritic Complex	41	34	4	122	83
	5	Biotite Granodiorite	3	2	1	6	60
	28	Leucogranite	3	1	1	6	60
	8	F.g. Granite, Aplite	7	4	1	14	67
Huntington Mountain	21	Dioritic Complex	41	29	3	105	71
	3	Porph. Quartz Monzonite	8	11	1	20	140
	17	Leucogranite, Graphic Granite	3	2	1	6	65

Table 11-1d. F

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	50	20	30	100	42
Deep Cove	9	Granite	570	150	440	870	26
Gillis Mountain	9	Quartz Monzodiorite	630	100	500	800	15
	28	Porphyritic Granite	510	120	140	800	24
	7	Fine grained Granite	620	70	500	730	12
White Point	5	Granodiorite	670	360	420	1380	54
	34	Granite	430	90	150	580	21
Cape Smoky	7	Quartz Diorite, Granodiorite	450	90	330	560	19
	5	Granodiorite	460	90	390	620	20
	34	Biotite Granite	370	80	280	600	22
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	550	140	380	930	26
	11	Hbld. Biot. Granite, Granodiorite	480	170	370	940	35
	13	Biot. Granite, Leucogr.	430	120	310	690	28
	5	Qtz. Diorite, Granodior.	630	80	520	750	13
	4	Porph. Quartz Monzonite	530	170	430	790	32
Kellys Mountain	13	Dioritic Complex	480	160	260	790	34
	5	Biotite Granodiorite	520	100	370	620	20
	28	Leucogranite	460	260	180	1520	57
	8	F.g. Granite, Aplite	360	100	250	500	27
Huntington Mountain	21	Dioritic Complex	570	140	310	820	24
	3	Porph. Quartz Monzonite	630	210	400	950	45
	17	Leucogranite, Graphic Granite	550	350	200	1630	63

Table 11-1e. Pb

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	11	2	8	14	22
Deep Cove	9	Granite	50	41	15	150	82
Gillis Mountain	9	Quartz Monzodiorite	18	8	5	33	43
	28	Porphyritic Granite	99	199	8	950	201
	7	Fine grained Granite	103	156	18	446	152
White Point	5	Granodiorite	29	7	19	37	24
	34	Granite	44	34	21	214	77
Cape Smoky	7	Quartz Diorite, Granodiorite	4	3	2	11	94
	5	Granodiorite	2	<1	2	4	37
	34	Biotite Granite	7	4	2	16	57
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	11	6	2	23	53
	11	Hbld. Biot. Granite, Granodiorite	19	40	2	138	204
	13	Biot. Granite, Leucogr.	22	35	5	138	160
	5	Qtz. Diorite, Granodior.	15	7	3	20	46
	4	Porph. Quartz Monzonite	24	15	14	46	62
Kellys Mountain	13	Dioritic Complex	9	8	2	33	91
	5	Biotite Granodiorite	7	4	2	12	51
	28	Leucogranite	11	5	2	28	44
	8	F.g. Granite, Aplite	15	10	4	32	66
Huntington Mountain	21	Dioritic Complex	12	6	2	25	51
	3	Porph. Quartz Monzonite	11	5	6	16	44
	17	Leucogranite, Graphic Granite	15	5	2	6	35

Table 11-1f. Mo

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	3	<1	2	4	31
Deep Cove	9	Granite	6	2	3	10	33
Gillis Mountain	9	Quartz Monzodiorite	4	1	3	6	25
	28	Porphyritic Granite	4	2	2	9	39
	7	Fine grained Granite	5	1	4	7	26
White Point	5	Granodiorite	1	1	<1	2	48
	34	Granite*	2	<1	<1	4	37
Cape Smoky	7	Quartz Diorite, Granodiorite	2	<1	1	3	25
	5	Granodiorite	3	3	2	8	79
	34	Biotite Granite	2	<1	1	3	24
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	2	<1	1	3	24
	11	Hbld. Biot. Granite, Granodiorite	2	<1	1	3	33
	13	Biot. Granite, Leucogr.	2	<1	1	3	21
	5	Qtz. Diorite, Granodior.	2	<1	1	3	27
	4	Porph. Quartz Monzonite	3	<1	2	3	29
Kellys Mountain	13	Dioritic Complex	2	<1	1	3	24
	5	Biotite Granodiorite	2	<1	2	3	20
	28	Leucogranite	2	<1	1	4	40
	8	F.g. Granite, Aplite	3	2	1	6	60
Huntington Mountain	21	Dioritic Complex	2	1	1	6	48
	3	Porph. Quartz Monzonite	3	1	1	4	43
	17	Leucogranite, Graphic Granite	3	1	2	6	36

*High value of 410 omitted from calculations.

Table 11-1g. Rb

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	243	86	123	338	35
Deep Cove	9	Granite	178	53	54	235	30
Gillis Mountain	9	Quartz Monzodiorite	101	20	73	125	20
	28	Porphyritic Granite	170	28	129	241	17
	7	Fine grained Granite	159	17	137	190	10
White Point	5	Granodiorite	135	28	91	172	21
	34	Granite	216	59	86	326	27
Cape Smoky	7	Quartz Diorite, Granodiorite	55	21	30	89	39
	5	Granodiorite	78	19	55	101	24
	34	Biotite Granite	104	36	19	177	35
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	84	27	48	130	32
	11	Hbld. Biot. Granite, Granodiorite	74	19	38	97	26
	13	Biot. Granite, Leucogr.	141	29	94	197	21
	5	Qtz. Diorite, Granodior.	87	7	78	97	8
	4	Porph. Quartz Monzonite	95	22	64	114	24
Kellys Mountain	13	Dioritic Complex	51	26	22	115	51
	5	Biotite Granodiorite	81	13	66	99	17
	28	Leucogranite	139	45	67	251	33
	8	F.g. Granite, Aplite	186	79	88	285	43
Huntington Mountain	21	Dioritic Complex	75	48	18	186	64
	3	Porph. Quartz Monzonite	99	40	70	144	40
	17	Leucogranite, Graphic Granite	201	69	104	362	34

Table 11-1h. Sr

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	46	7	36	55	16
Deep Cove	9	Granite	225	74	85	342	33
Gillis Mountain	9	Quartz Monzodiorite	465	35	414	540	8
	28	Porphyritic Granite	302	38	220	395	13
	7	Fine grained Granite	244	25	217	288	10
White Point	5	Granodiorite	676	225	403	990	33
	34	Granite	244	233	41	1350	95
Cape Smoky	7	Quartz Diorite, Granodiorite	433	86	329	550	20
	5	Granodiorite	343	114	210	465	33
	34	Biotite Granite	222	135	59	641	61
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	395	170	10	220	43
	11	Hbld. Biot. Granite, Granodiorite	277	55	148	325	20
	13	Biot. Granite, Leucogr.	132	117	17	350	88
	5	Qtz. Diorite, Granodior.	456	63	384	550	14
	4	Porph. Quartz Monzonite	348	80	232	402	23
Kellys Mountain	13	Dioritic Complex	387	86	272	533	22
	5	Biotite Granodiorite	301	222	121	680	74
	28	Leucogranite	113	81	28	411	72
	8	F.g. Granite, Aplite	58	42	11	121	72
Huntington	21	Dioritic Complex	314	62	171	434	20
	17	Leucogranite, Graphic Granite	85	37	36	172	44

Table 11-1i. S

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	80	90	20	240	111
Deep Cove	9	Granite	2490	2980	70	7750	120
Gillis Mountain	9	Quartz Monzodiorite	2110	2550	100	6900	121
	28	Porphyritic Granite	1230	1510	10	5900	123
	7	Fine grained Granite	2340	1420	300	4800	61
White Point	5	Granodiorite	150	250	20	660	175
	34	Granite	30	20	10	90	68
Cape Smoky	7	Quartz Diorite, Granodiorite	1180	1570	100	3900	133
	5	Granodiorite	220	190	40	510	85
	34	Biotite Granite	50	60	10	310	120
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	80	70	118	630	85
	11	Hbld. Biot. Granite, Granodiorite	90	90	20	300	105
	13	Biot. Granite, Leucogr.	50	40	10	170	85
	5	Qtz. Diorite, Granodior.	180	160	60	440	90
	4	Porph. Quartz Monzonite	150	230	30	500	152
Kellys Mountain	13	Dioritic Complex	620	510	20	1360	83
	5	Biotite Granodiorite	100	50	60	170	45
	28	Leucogranite	80	70	20	260	83
	8	F.g. Granite, Aplite	130	120	60	360	92
Huntington Mountain	21	Dioritic Complex	790	690	20	2120	88
	3	Porph. Quartz Monzonite	60	20	40	80	33
	17	Leucogranite, Graphic Granite	310	640	20	2460	208

Table 11-1j. Sn

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	5	<1	5	6	10
Deep Cove	9	Granite	3	2	1	7	57
Gillis Mountain	9	Quartz Monzodiorite	2	<1	1	3	27
	28	Porphyritic Granite	2	1	1	7	56
	7	Fine grained Granite	3	1	<1	4	48
White Point	5	Granodiorite	4	2	1	7	52
	34	Granite	4	4	2	27	97
Cape Smoky	7	Quartz Diorite, Granodiorite	2	<1	1	3	35
	5	Granodiorite	2	<1	1	3	49
	34	Biotite Granite	1	<1	<1	3	28
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	2	1	1	5	40
	11	Hbld. Biot. Granite, Granodiorite	2	<1	1	4	36
	13	Biot. Granite, Leucogr.	4	2	2	8	48
	5	Qtz. Diorite, Granodior.	2	<1	1	3	36
	4	Porph. Quartz Monzonite	2	<1	1	2	31
Kellys Mountain	13	Dioritic Complex	3	2	1	8	73
	5	Biotite Granodiorite	3	<1	2	3	27
	28	Leucogranite	3	2	1	10	62
	8	F.g. Granite, Aplite	4	2	1	7	51
Huntington Mountain	21	Dioritic Complex	2	1	1	7	54
	3	Porph. Quartz Monzonite	2	1	2	4	41
	17	Leucogranite, Graphic Granite	2	1	1	4	39

Table 11-1k. U

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	9	3	5	12	30
Deep Cove	9	Granite	6	1	4	7	16
Gillis Mountain	9	Quartz Monzodiorite	2	<1	2	3	19
	28	Porphyritic Granite	4	<1	3	5	14
	7	Fine grained Granite	4	<1	3	4	8
White Point	5	Granodiorite	2	1	<1	4	65
	34	Granite	3	2	1	12	68
Cape Smoky	7	Quartz Diorite, Granodiorite	1	<1	<1	2	62
	5	Granodiorite	1	<1	<1	1	18
	34	Biotite Granite	2	<1	<1	3	35
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	2	1	<1	3	46
	11	Hbld. Biot. Granite, Granodiorite	2	<1	<1	2	32
	13	Biot. Granite, Leucogr.	3	<1	2	4	21
	5	Qtz. Diorite, Granodior.	1	<1	<1	2	39
	4	Porph. Quartz Monzonite	2	<1	2	3	25
Kellys Mountain	13	Dioritic Complex	1	<1	<1	3	67
	5	Biotite Granodiorite	1	<1	1	2	22
	28	Leucogranite	2	<1	1	4	33
	8	F.g. Granite, Aplite	3	<1	2	4	21
Huntington Mountain	21	Dioritic Complex	2	2	<1	7	95
	3	Porph. Quartz Monzonite	3	<1	3	3	13
	17	Leucogranite, Graphic Granite	5	2	3	8	37

Table 11-11. Zn

PLUTON	n	PHASE	MEAN	S.D.	MIN.	MAX.	C.V.
Petit-de-Grat	8	Leucogranite	14	6	9	5	41
Deep Cove	9	Granite	230	186	44	600	81
Gillis Mountain	9	Quartz Monzodiorite	84	20	53	120	24
	28	Porphyritic Granite	153	198	30	780	130
	7	Fine grained Granite	154	134	61	450	87
White Point	5	Granodiorite	60	26	23	98	44
	34	Granite	41	13	14	79	31
Cape Smoky	7	Quartz Diorite, Granodiorite	67	15	46	86	23
	5	Granodiorite	48	22	17	74	46
	34	Biotite Granite	32	9	13	50	29
St. Anns Mountain	11	Hbld. Granodiorite, Qtz. Monzodiorite, etc.	71	25	32	119	39
	11	Hbld. Biot. Granite, Granodiorite	52	11	35	69	21
	13	Biot. Granite, Leucogr.	37	19	10	69	52
	5	Qtz. Diorite, Granodior.	116	33	85	160	29
	4	Porph. Quartz Monzonite	56	4	53	60	6
Kellys Mountain	13	Dioritic Complex	79	20	45	110	25
	5	Biotite Granodiorite	49	16	25	70	33
	28	Leucogranite	22	9	5	41	41
	8	F.g. Granite, Aplite	24	15	9	48	63
Huntington Mountain	21	Dioritic Complex	98	19	60	138	19
	3	Porph. Quartz Monzonite	38	1	36	40	5
	17	Leucogranite, Graphic Granite	36	11	24	60	29

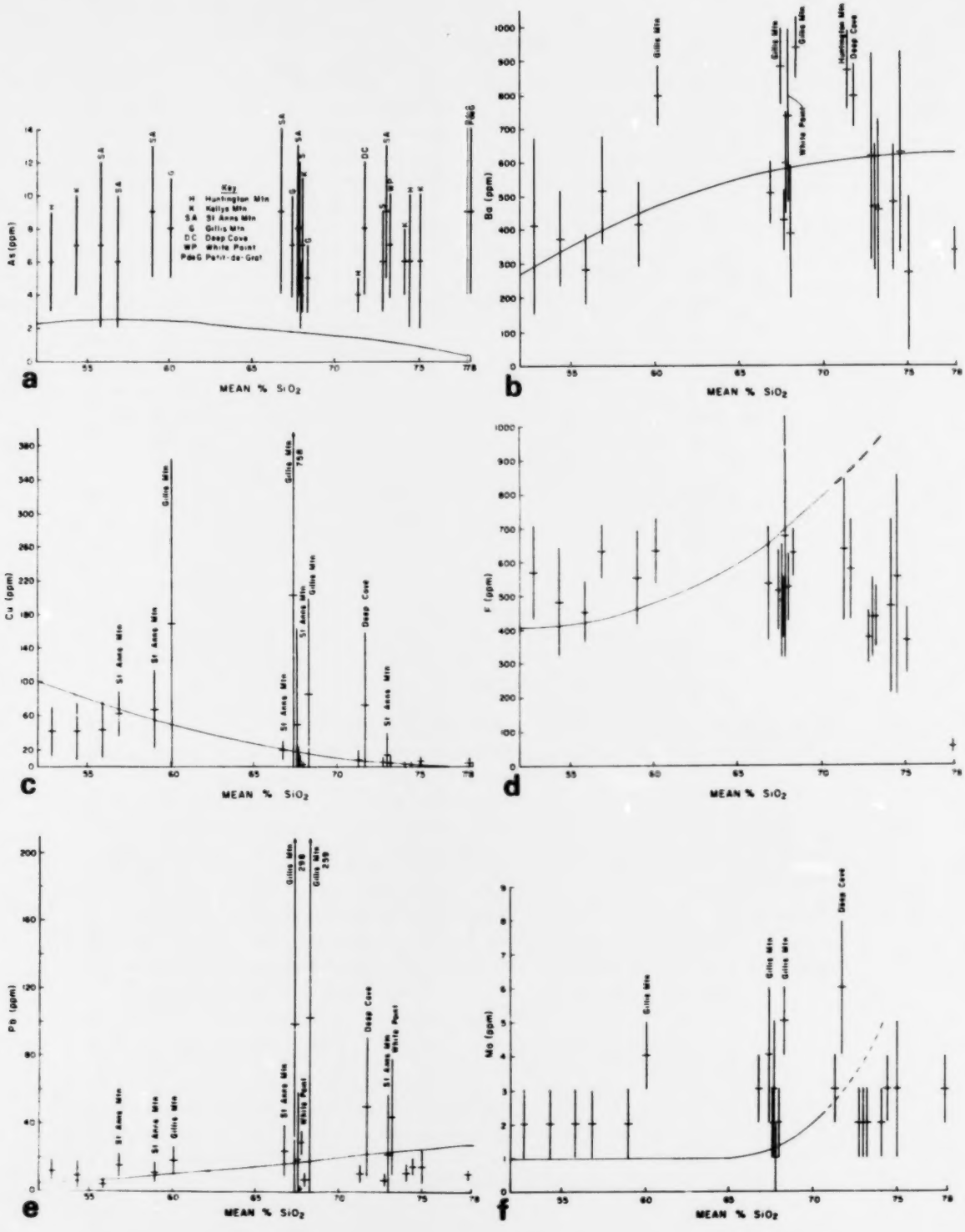


Figure 11-3. Summary silica variation diagrams for trace elements in the plutons of this study. Mean ± standard deviation are shown for each phase of each pluton. Data are derived from Table 11-1. Key to abbreviations is shown on Figure 11-3a. Only plutons of particular interest (as discussed in the accompanying text) are labelled on Figures 11-3b to 11-3l. Lines are average trends for calc-alkalic plutons from Gribble (1969).

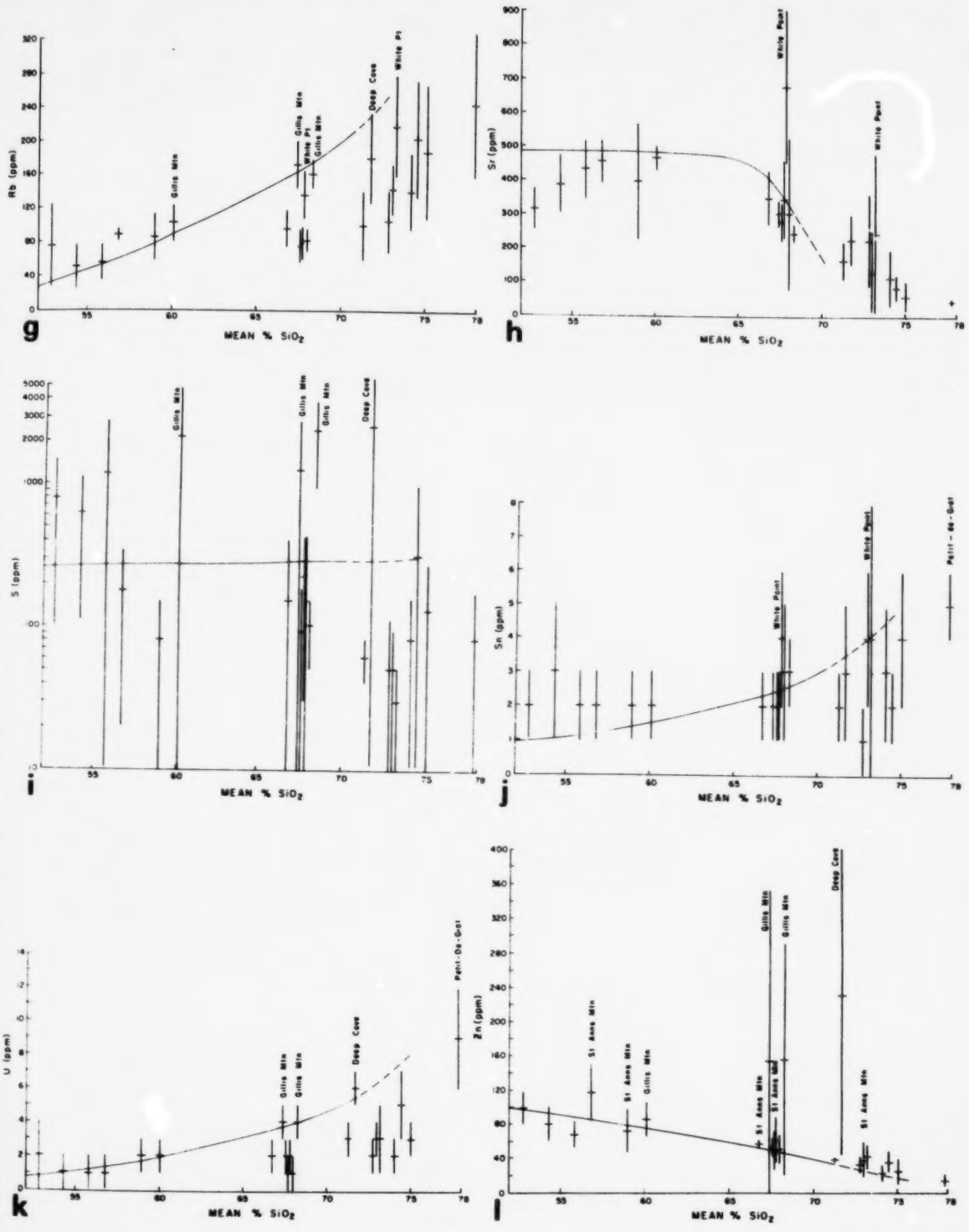


Figure 11-3. Continued.

in Sr, and the granodiorite samples are especially high in Sr. The granitic samples do not reveal any consistent differences between mineralized and apparently unmineralized plutons (Fig. 11-4).

SULPHUR (Table 11-1i, Figure 11-3i)

Sulphur is higher in the more mafic rocks and generally decreases with increasing SiO_2. However there is wide scatter from virtually 0 to more than 2000 ppm. The more mafic rocks of St. Anns Mountain pluton are lower and less varied in S than those of other plutons. Gillis Mountain and Deep Cove data do not follow the pattern of the other plutons and show an extremely wide range in S values, a feature which is again indicative of the presence of mineralization. Comparison of granitic samples alone reveals the same pattern (Fig. 11-5f). St. Anns Mountain samples do not contain particularly high S, but do show an anomalous positively skewed distribution.

TIN (Table 11-1j, Fig. 11-3j)

Tin values are low in all plutons and show only a slight tendency to increase and become more variable with increasing SiO_2. White Point pluton is slightly higher in Sn on average than the others, although not in the granitic rocks (Fig. 11-4).

URANIUM (Table 11-1k, Figure 11-3k)

Uranium shows a consistent pattern of increasing with increasing SiO_2. Some of the more felsic rocks (e.g. Petit-de-Grat and White Point) show some interesting U values (up to 12 ppm). Gillis Mountain and Deep Cove plutons are somewhat higher in U than other plutons, which contain less U than the average calc-alkalic granite of Gribble (1969).

ZINC (Table 11-1l, Figure 11-3l)

Zinc values decrease with increasing SiO_2 and all plutons show similar patterns with the exception of Gillis Mountain and Deep Cove which show higher means and wider ranges, again correlated with the presence of mineralization. In the "granites", the patterns are similar to Pb, except White Point does not show elevated levels (Figs. 11-4, 11-5g).

BACKGROUND AND ANOMALOUS POPULATIONS

One of the aims of this study is to establish "type plutons" to which others in Cape Breton Island can be compared. For this purpose, it is useful to establish background and threshold values for these plutons as a group. This can be done by analyzing the data for the "granitic" phases of the plutons, containing more than 65% SiO_2, thus avoiding problems arising from the presence of a range of rock types from mafic to felsic occurring in most, but not all plutons. The major element data are not included in this analysis because they generally show normal distributions and hence are adequately characterized by the means and standard deviations (Fig. 11-2).

Among the trace elements, only Rb and Ba show approximately normal distributions, the other elements having approximately log-normal distributions. Cumulative frequency plots are shown in Figures 11-6a to 11-6l, and the background and threshold values derived from these plots are summarized in Table 11-2. In the conventional manner, the background is taken to be the value at 50% cumulative frequency, and the standard deviation (1σ) is the value at 84.13% cumulative frequency minus the background value. The threshold is the value at 97.6% cumulative frequency, and the mean anomalous population (where it can be derived) is the value read from the anomalous population line at 50% cumulative frequency.

Table 11-2. Background values and other statistical data for "granitic" samples from the plutons in this study. Data are derived from cumulative frequency plots of Figure 11-6. A question mark indicates that the value could not be read from the plot, for reasons discussed in the text.

ELEMENT	BACKGROUND	+1σ	THRESHOLD	MEAN ANOM VALUE
As	5	3	13	None
Ba	520	195	1000	?
Cu	3.5	21.6	155	?
F	380	182	794	None
Mo	1.9	1.3	5.1	5.2
Pb	12.6	20.8	89	?
Rb	128	46	216	?
Sr	133	66	668	None
S	50	138	750	2511
Sn	2.2	1.7	6.8	None
U	2.3	2.2	6.2	None
Zn	33	27	102	234
W	<4			

No high anomalous populations are present for As, F, Sr, Sn, or U. Scatter in As data (Fig.11-6a) may be the result of analytical uncertainties (Appendix B). Anomalously low F values in Petit-de-Grat pluton create scatter at low cumulative percentages (Fig. 11-6b). Somewhat high and less variable than usual Sr values in the Gillis Mountain-Deep Cove plutons cause the overall Sr population to depart from a log-normal distribution, and hence the cumulative frequency plot is not a straight line (Fig. 11-6c). If the Gillis Mountain-Deep Cove data are excluded, the population is log normal. Tin (Fig. 11-6d) and U (Fig. 11-6e) show reasonable log-normal distributions.

Ba and Rb both have anomalous populations. Wide range in Ba in most plutons, as illustrated by the histogram in Figure 11-5a, makes characterization of the anomalous population difficult on the cumulative frequency plot (Fig. 11-6f). The histogram (Fig. 11-5a) clearly shows that Gillis Mountain and Deep Cove are typically higher in Ba than other pultons. The anomalous Rb population (Fig. 11-6g) consists mostly of samples from Gillis Mountain-Deep Cove, White Point, and Petit-de-Grat plutons, as shown in the histogram (Fig. 11-5e), although Huntington Mountain and Kellys Mountain plutons have some high values.

Copper has a complex cumulative frequency plot, indicating a polymodal distribution (Fig. 11-6h). The reason for this is clear from the

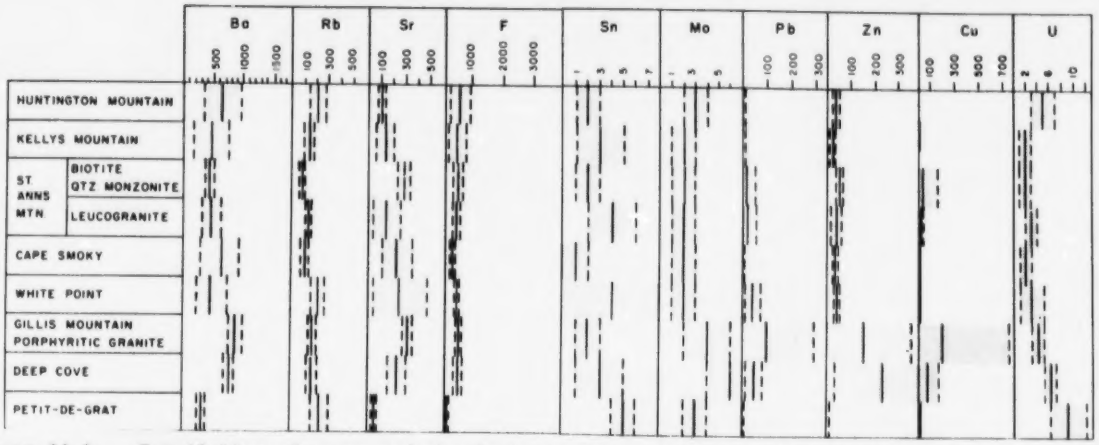


Figure 11-4. Compilation of means and standard deviations for trace elements in the "granitic" phases of the plutons (those containing more than 65% SiO_2).

histogram (Fig 11-5b). The large number of samples with very low Cu form the normal population. However, a few samples from all plutons range up to 10 or more ppm, forming a second (anomalous?) population. Then a few samples from St. Anns Mountain and most samples from Gillis Mountain-Deep Cove form truly anomalous population. Thus the cumulative frequency plot cannot be interpreted in the usual way. The background and threshold were read from line through the low "normal" population.

Molybdenum has an anomalous population, mean 5.0 ppm (Fig. 11-6i), largely from Gillis Mountain-Deep Cove samples (Fig 11-5d).

Lead has complexities within the anomalous population (Fig. 11-6j), the origin of which is apparent from the histogram (Fig. 11-5c). Both White Point and Gillis Mountain-Deep Cove have anomalous Pb values.

Sulphur values show a considerable range, but most samples in the anomalous population (Fig.11-6k) are from Gillis Mountain-Deep Cove (Fig. 11-5f).

Zinc has an anomalous population (Fig. 11-6l) resulting from Gillis Mountain-Deep Cove plutons (Fig. 11-5g).

In summary, none of the plutons has anomalous populations for As, F, Sr, Sn, or U (Table 11-2). The strongly mineralized Gillis Mountain-Deep Cove plutons have anomalous Ba, Cu, Mo, Pb, Rb, S, and Zn populations. In contrast, the St. Anns Mountain pluton, also mineralized, shows only a few anomalous Cu values. This is probably because mineralization is not as widespread in the St. Anns Mountain pluton as it is in Gillis Mountain-Deep Cove. The White Point pluton has anomalous Pb population. None of the other plutons show anomalous populations in Ba, Cu, Mo, Pb, Rb, S or Zn, although a few samples may exceed the threshold value.

CONCLUSIONS

The three Late Hadrynian-Cambrian plutons (Kellys Mountain, Huntington Mountain, St. Anns Mountain) are similar to one another in petrography and geochemistry. The mineralized St. Anns Mountain pluton does not differ significantly from the other two, except perhaps in being more highly altered in some areas and in displaying some weakly anomalous trace element patterns. However, the known mineralization is very limited in distribution and could be unrelated to the main intrusive phases.

The Cape Smoky pluton is not petrographically identical to the above group of plutons, but shows similar chemical patterns.

The Devono-Carboniferous plutons are different from all of the above, but also from one another, with the exception of Gillis Mountain and Deep Cove. The geographic location, geological setting, petrography, mineralization, and geochemistry of these two plutons suggest that they are comagmatic and set them apart from the other Devono-Carboniferous, as well as older plutons. Both White Point and Petit-de-Grat plutons are distinctive igneous bodies, with many distinctive petrographic and chemical features.

Hence the marked dissimilarity among the Devono-Carboniferous plutons contrasts with the relative similarity among the older plutons.

As a group, these plutons of Cape Breton Island differ chemically in some ways from average calc-alkalic plutonic rocks described by Gribble (1969). They may be higher in As, and the granitic phases are lower in F, Rb, Sn, and U. In addition mineralized plutons show anomalous data for Ba, Cu, Pb, Mo, Rb, S, and Zn. The White Point pluton, although apparently unmineralized, is anomalous in Rb, U, and especially Pb.

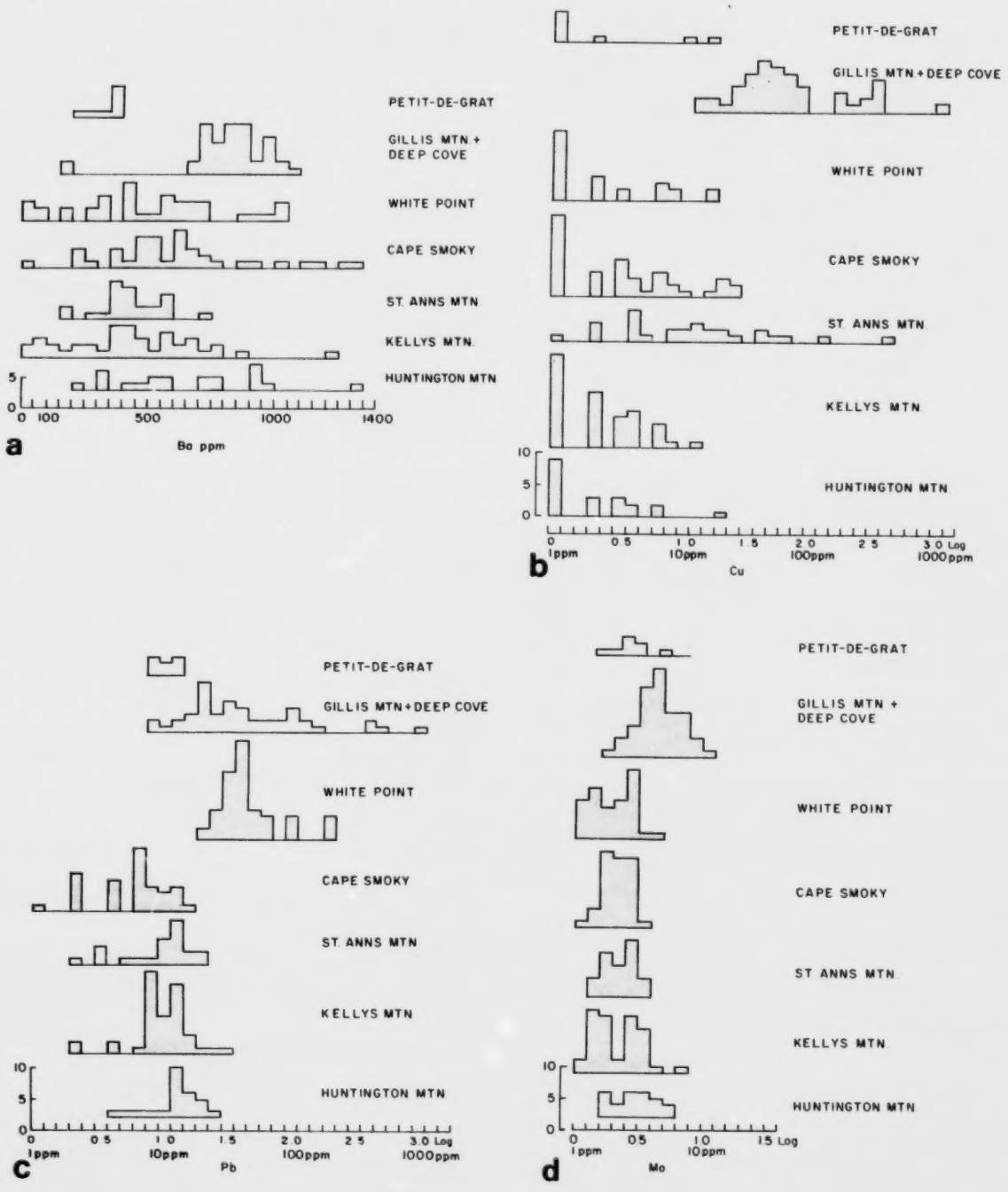
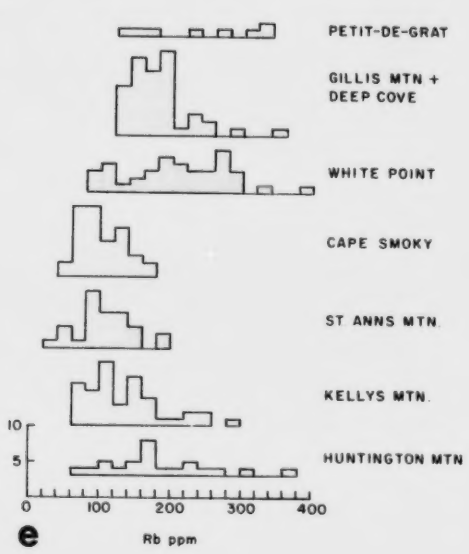
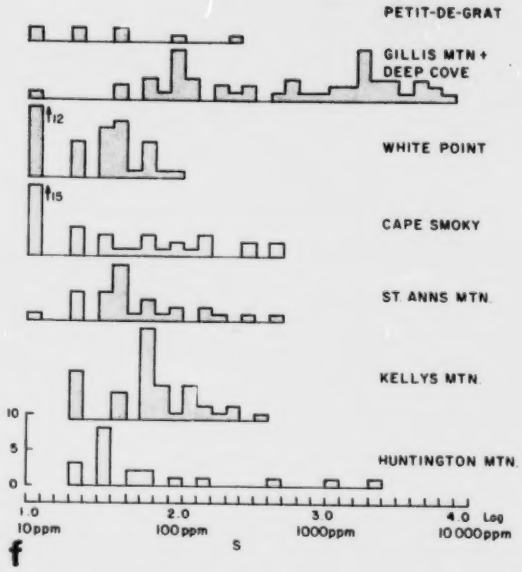
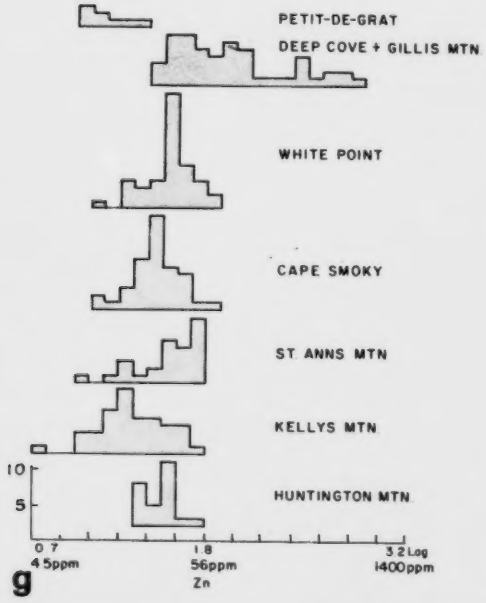


Figure 11-5. Histograms of data for selected trace elements in the "granitic" phases of the plutons. Vertical scale indicates number of samples.







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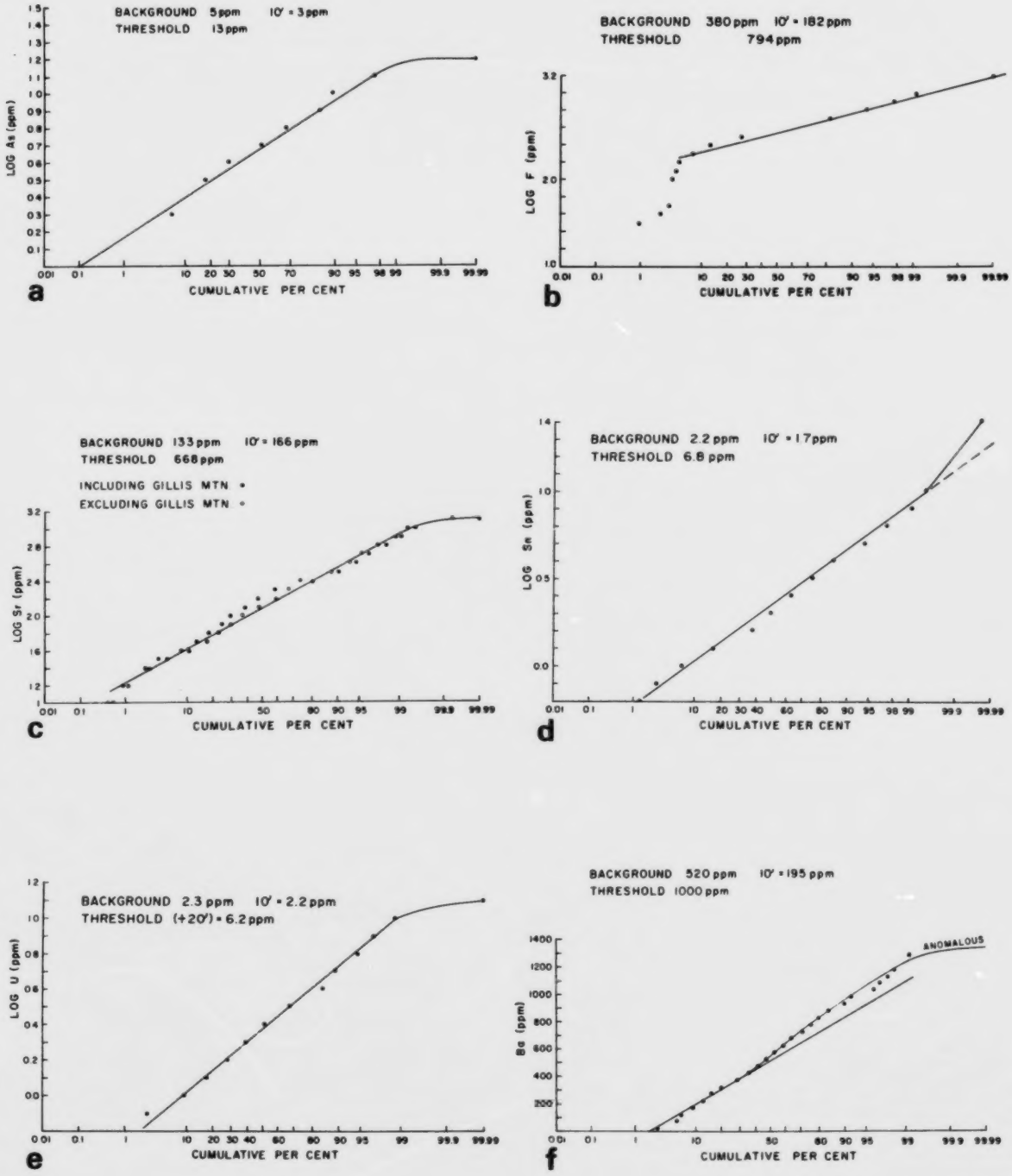
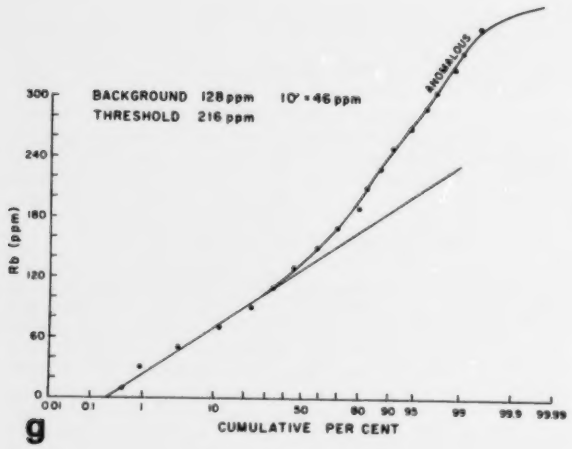
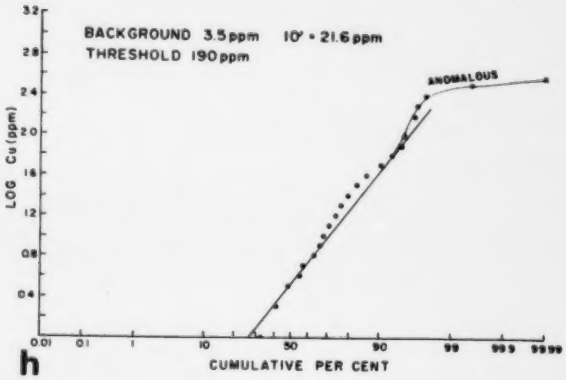
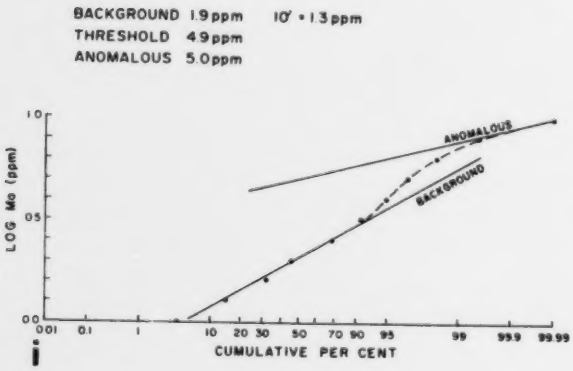
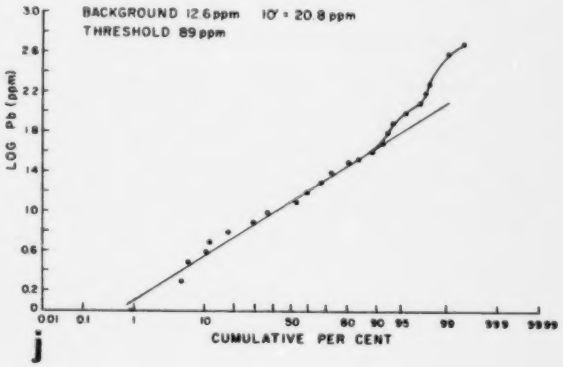


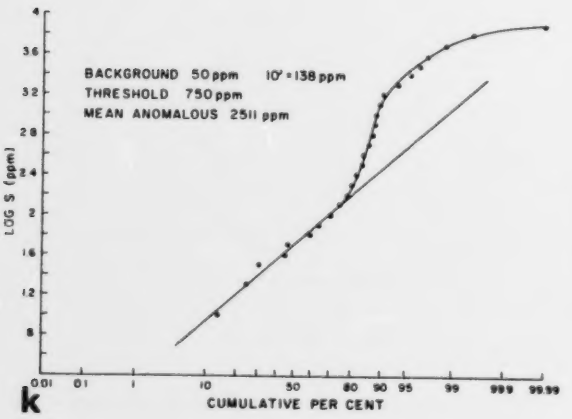
Figure 11-6. Cumulative frequency curves for trace element data from "granitic" samples in all plutons of this study.











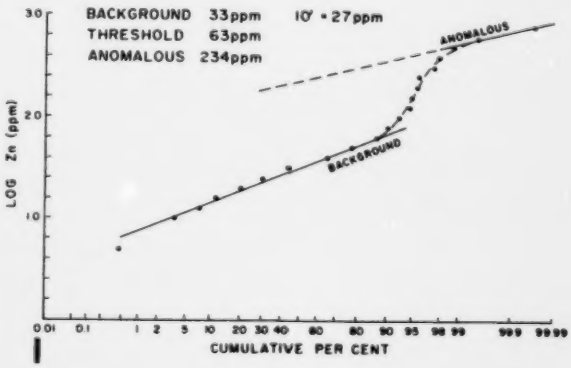


Figure 11-6. Continued.

CHAPTER 12
ECONOMIC IMPLICATIONS

INTRODUCTION

One of the aims of this project is to asses the economic potential of granitoid plutons in Cape Breton Island. In this chapter the plutons are examined in the light of criteria used in other regions for this purpose.

S-TYPE AND I-TYPE CHARACTERISTICS

A popular approach in the study of granitoid plutons is their classification as S-type (derived from a "sedimentary" source) or I-type (derived from an "igneous" source) (Chappell and White, 1974; White and Chappell, 1977). Although it is not the intent of this report to discuss the petrogenesis of plutons in Cape Breton Island, it is relevant to briefly describe features of these plutons in relation to this classification scheme because of the different types of mineralization ascribed to S-type and I-type granitoid rocks. S-type plutons are reported to be associated with Sn and related types of mineralization whereas I-type plutons have Cu-Mo-W mineralization (Chappell and White, 1974).

The main characteristics are summarized in Table 12-1. With the exception of the White Point pluton, the plutons of this study are clearly I-type, and as such would not be anticipated to have associated Sn (or U) mineralization, but would be expected to have Cu-Mo-W mineralization. This is consistent with known occurrences in Cape Breton Island, and with data discussed in the sections which follow.

Table 12-1. Summary of some features of I-type granites (taken from Chappell and White, 1974; White and Chappell, 1977) exhibited by granites of this study.

Most plutons show these features of I-Type Granites:	Exceptions
1. Range from mafic to felsic	White Point, Petit-de-Grat
2. Hornblende common Accessory sphene No primary muscovite	White Point (Muscovite-biotite granite)
3. Metaluminous Contain normative diopside or normative corundum <1%	White Point, Gillis Mountain (slightly peraluminous)
4. Na_2O> 3.2% in felsic rocks	
5. Near-linear variation diagrams	
6. Low initial $^{87}Sr/^{86}Sr$ (less than 0.706)	White Point (0.7097 ± 0.0011)

COMPARISON WITH "SPECIALIZED" GRANITES

Most studies of the relationship between geochemical factors and mineralization in granitoid rocks have been concerned with those bearing ores of Sn, W, Mo, Be, Nb, and Ta, the main emphasis being on the "tin-specialized" or "tin-generating" granites. As noted by Stemprok (1979, p. 21), opinions on this relationship "vary from the optimistic (suggesting possibilities of finding ores according to the associated granite type), to the pessimistic (which state that ore-bearing granites can be identified only by the presence of ore deposits)". On the optimistic side, various geochemical criteria have been suggested for distinguishing between "tin-bearing" and "tin-barren" granites. In this section some of these criteria are applied to the granites of Cape Breton Island.

MAJOR ELEMENT GEOCHEMISTRY

As shown in Chapter 11, even within the "granitic" phases, SiO_2 and other major element oxides show considerable range. However, in most respects they resemble average granites of Tischendorf (1977) (Fig. 12-1). Differences can be related to petrography. For example, leucongranites, with higher than average SiO_2, naturally have lower than average TiO_2, Al_2O_3, Fe_2O_3T, MnO, and CaO, whereas less felsic granites with less than average SiO_2 tend to show the opposite. None of the plutons shows the combination of high silica, high alumina, and low lime, titania, and iron which is characteristic of specialized granites (Fig. 12-1). Granites of Petit-de-Grat and possibly White Point have the most similarities to specialized granites.

TRACE ELEMENT GEOCHEMISTRY

As illustrated by Figure 12-2 none of the Cape Breton granites matches specialized granites in Rb, F, Li, and Sn, although Mo values are similar. Given the low concentrations of Mo involved, uncertainty in analytical data make this a poor element on which to rely. Furthermore Cape Breton granites all contain less than 4 ppm W, whereas specialized granites contain 7 ± 3 ppm W.

ELEMENT RATIOS

(1) **K/Na.** According to Stemprok (1979), this ratio is about 1.2 in "normal" granites and 1.6 in "specialized" granites. K/Na ratios in Cape Breton granites are about 1.2 (Table 12-2), with the exception of 1.4 in the Petit-de-Grat pluton.

(2) **K/Rb.** According to Tischendorf (1977), this ratio is more than 100 in normal granites

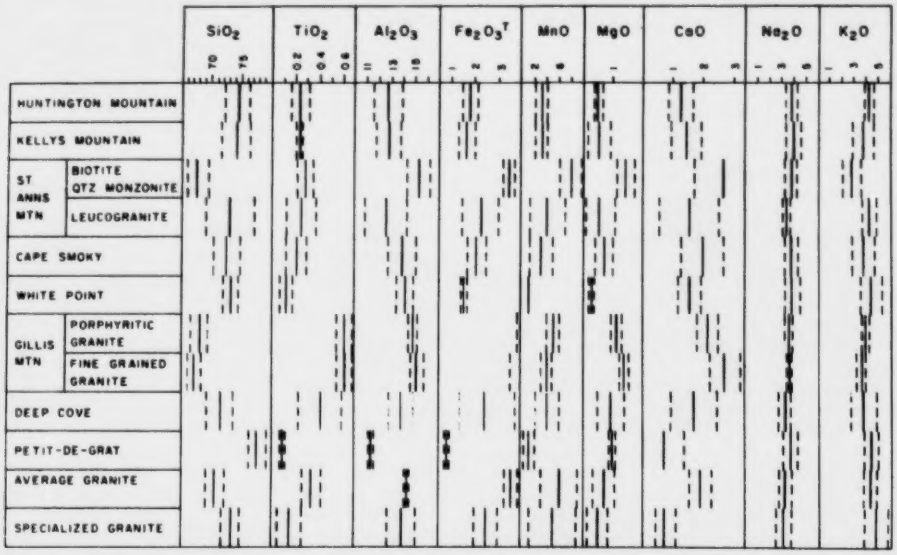


Figure 12-1. Means and standard deviations of major element oxides in "granites" of this study compared to Average and Specialized Granites of Tischendorf (1977).

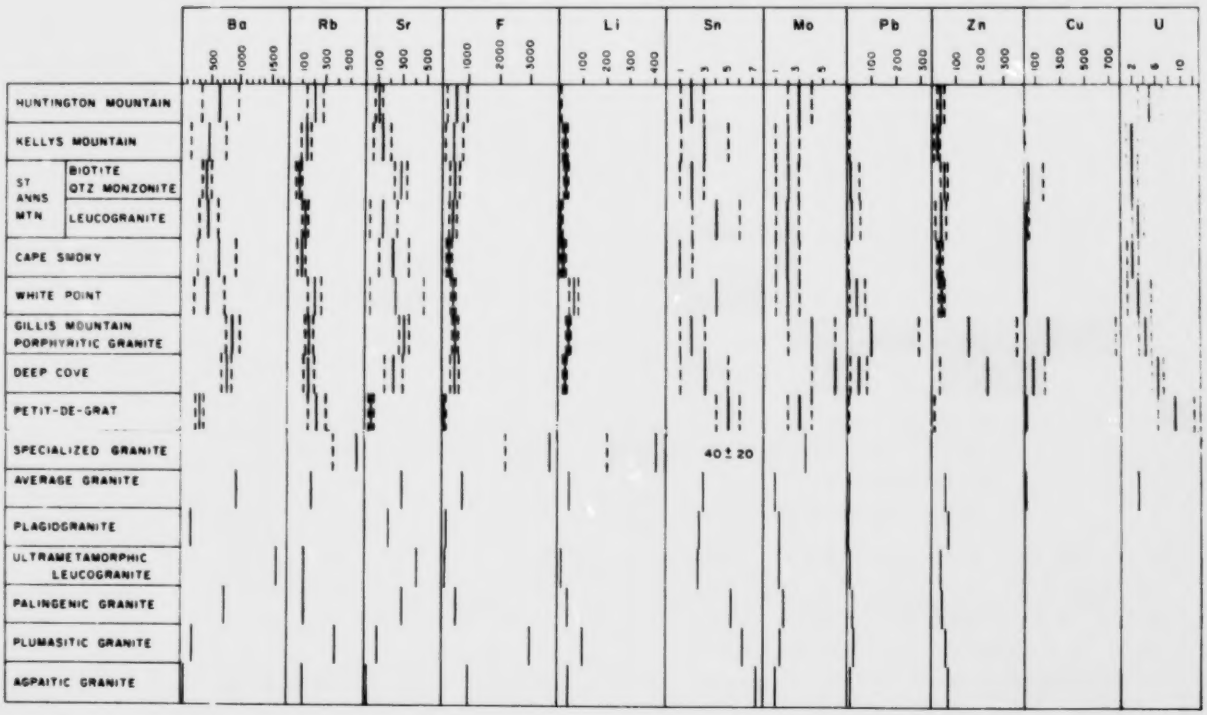


Figure 12-2. Means and standard deviations of trace elements in "granites" of this study compared to Specialized and Average Granites of Tischendorf (1977) and Vingradov (1962) and the granite classification of Tauson and Kozlov (1973). Li data from Chapter 10.

and less than 100 in specialized granites. K/Rb ratios are more than 100 in all Cape Breton granites (Table 12-2). The ratios are particularly high in the biotite granite of Cape Smoky pluton, as well as in the biotite quartz monzonite of St. Anns Mountain pluton.

(3) **Mg/Li** ratios are low in specialized compared to normal granites (Beus and Stitnin, 1968). Only White Point pluton has low Mg/Li (Table 12-2), as a result of a high Li content (Table 10-1).

(4) **Li/Zn** values are generally less than 1 in normal granites and more than 1 in specialized granites. According to this criterion, both White Point and Kellys Mountain granites could be specialized, although in the case of Kellys Mountain other criteria are definitely negative.

Table 12-2. Selected elemental ratios in Average and Specialized Granites (from sources given in the text) compared to those in "granites" of this study. HG + GD = hornblende biotite granite and granodiorite; LGr = leucogranite; PGr = porphyritic granite; FgGr = fine grained granite.

	K/Na	K/Rb	Mg/Li	Li/Zn
Average	1.2	>100	270 ± 80	<1
Specialized	**1.6**	**<100**	**75 ± 30**	**>1**
Huntington Mtn.	1.2	176	620	0.14
Kellys Mtn.	1.1	229	148	1.1
St. Anns HGD	0.8	322	435	0.44
LGr	1.3	242	248	0.22
Cape Smoky	1.1	300	258	0.59
White Point	1.3	169	31	1.5
Gillis Mtn. PGr	1.1	172	319	0.2
FgGr	1.3	209	264	0.2
Deep Cove	1.2	174	352	0.1
Petit-de-Grat	1.4	153	-	-

Classification of Tauson and Kozlov (1973)

Tauson and Kozlov (1973) divided granites into five types on the basis of geochemistry:

(1) Plagiogranites, which are terminal felsic differentiates of gabbroic magma.

(2) Ultrametamorphic leucogranites, which form by partial melting of highly metamorphosed rocks.

(3) Palingenic granites, which form by complete melting of metamorphic rocks in the earth's crust.

(4) Plumasitic leucogranites (often termed "tin-bearing"), which are the latest felsic differentiates of large chambers of normal palingenic granites or felsic differentiates of alkali basalts of high volatile content.

(5) Agpaitic leucogranites, which are terminal differentiates of subalkaline palingenic granite magma or felsic differentiates of alkali basalt magma of lower volatile content.

Trace element contents of examples of these five granite type are shown on Figure 12-2. It is apparent that the granites of Cape Breton Island are most similar to palingenic granites. A possible exception is the Petit-de-Grat leucogranite, which shows similarity to plumasitic or agpaitic granites in terms of Ba and Sr (but not F and Zn). Palingenic granites are similar to the average granite of Tischendorf (1977).

ECONOMIC POTENTIAL

The data presented in this chapter show that the plutons of this study are not "specialized" in the sense of "tin-specialized" (e.g. Stemprok, 1979; Tischendorf, 1977). Even the White Point pluton, which is apparently of the petrologic type most suitable for specialization, does not display the chemical features which are said to be characteristic of specialization. Hence these plutons would not be expected to be associated with significant occurrences of Sn, U, or related elements. Thus they contrast markedly with the South Mountain batholith and other plutonic rocks in southern Nova Scotia which are specialized and known to contain Sn and U deposits (Smith and Turek, 1975).

On the other hand, the Cape Breton plutons may be associated with deposits of other types. Their petrology is generally appropriate for Cu-Mo-W mineralization, and several such occurrences are known already (e.g. Gillis Mountain-Deep Cove, St. Anns Mountain). This study has shown that plutons such as Gillis Mountain-Deep Cove which contain significant mineralization can be expected to show some anomalous chemical features. These can be recognized by comparison with the apparently unmineralized plutons, background levels in which have been defined by this study. Major elements are probably not distinctive; even Sn-specialized granites are difficult to recognize on this basis alone. However, trace element data are useful, especially Ba, Cu, Mo, Pb, and Zn and possibly others yet to be investigated. This chemical approach may not work if the mineralization is localized as on St. Anns Mountain, where most plutonic phases are apparently not mineralized and do not display any anomalous chemical features.

Additional plutons need to be studied in order to confirm the results of this initial project. Data from eight plutons selected from the many in Cape Breton Island cannot be considered to be definitive. Nevertheless these plutons are a basis for comparison for future studies, and appear to provide some criteria for the recognition of plutons with mineralization potential. If they are indeed representative of plutonic rocks in Cape Breton Island, then they also clearly indicate the type of exploration target in that area.

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APPENDIX A

METHOD OF STAINING ROCK SLABS

The staining of rock slabs was done at CLIM Laboratory, Technical University of Nova Scotia. The cut surface of the rock slab was immersed in concentrated hydrofluoric acid for 15 to 20 seconds. Then the slab was immersed while still wet in a saturated solution of sodium cobaltinitrite for 2 to 3 minutes. The sample was then washed in distilled water and allowed to dry. Potassium feldspar stained bright yellow, plagioclase, chalky white and quartz, dull grey. Modal analyses were done by counting on a transparent grid laid on the stained slab.

APPENDIX B

METHODS OF ANALYSES

SAMPLE PREPARATION

Powdered samples for analyses were prepared at the Laboratory for the Investigation of Minerals (CLIM), Technical University of Nova Scotia, Halifax. In the initial stages, samples for analyses were prepared for crushing by removing weathered rinds with a rock saw. This proved prohibitively slow, and subsequent samples were broken with a sledge hammer and fresh chips were hand picked. This fresh material was further crushed in a hardened steel jaw-crusher, and then split to produce a 100 g sample which was powdered to -100 mesh in a Shatterbox using a hardened steel container and puck.

ANALYTICAL TECHNIQUES

CLIM (TECHNICAL UNIVERSITY OF NOVA SCOTIA)

Samples were analyzed for the following elements using standard methods outlined by Shapiro (1975) and Shapiro and Brannoch (1962); Si, Al, Fe^{2+}, Fe^{3+}, Mg, Ca, Na, K, and P, as well as H_2O^+ and H_2O^-. Si and P were determined colourimetrically; Al, Fe^{3+}, Mg, Ca, Na, and K were determined using atomic absorption spectrometry; Fe^{2+} was analyzed using a titration method.

The elements Mn, Cu, Pb, Zn, Ni, Co, Cd, Li, and Rb, were determined by atomic absorption spectrophotometry following the method of Jeffrey (1970). The elements B, Ba, Be, Bi, Mo, Sb, Sn, Sr, Y, and Zr were determined using unpublished method QN12b of H. Champ of the Spectrographic Laboratory, Geological Survey of Canada, Ottawa.

Analyses of CO_2 followed the method outlined in the instruction manual for operation of a Leco Carbon Analyzer, published by Leco Corporation (1959), and employed an induction furnace and carbon determinator.

Determination of S followed the method outlined in the instruction manual for operation of a Leco Model 532 Sulphur Titrator.

Fluorine was determined after fusion and solution by selective ion electrode detection, following the method of Crenshaw and Ward (1975).

Aresenic analyses followed the procedure of Lynch and Mihailov (1963) followed by colourimetric determination.

Uranium was determined using neutron activation by the Atomic Energy Commission of Canada, Ottawa.

ACADIA UNIVERSITY

Twenty-five of the samples from Gillis Mountain pluton were analyzed for Si, Al, Fe, Ti, Mg, Mn, and Ca using atomic absorption spectrometry (Perkin-Elmer Model 303 Spectrometer). Na and K were determined by flame photometry (Evans Electroselenium Flame Photometer). The methods employed are a modification of the analytical methods of Buckley and Cranston (1971), and are outlined by Chu (1978). Rock samples used samples used as standards included JB-1, JG-1 (Geological Survey of Japan), AGV-1, G-2, GSP-1 (United States Geological Survey), and SY-2 (Canadian Certified Reference Materials Project). Accuracy and precision were discussed by O'Beirne (1979).

ACCURACY

In order to check the accuracy of the analyses at CLIM, Geological Survey of Canada Reference Standards SY-2 and SY-3 were included with most sample batches. Comparisons of the values obtained with the recommended values from Abbey (1977) are shown in Tables B-1 and B-2. In general the CLIM mean is within one standard deviation of the recommended value. Exceptions occur where concentrations are small, particularly below about 10 ppm. Obviously, absolute values of elements present in concentrations less than about 10 ppm should be used with caution.

Arsenic, in particular, appears to be unreliable, on the basis of the fact that the data obtained are consistently higher than in average or typical granitoid rocks. In fact, all of the As analyses were repeated at the suggestion of a reviewer of the initial draught of this report. The averages did not change, although scattered high values, especially in the Gillis Mountain pluton, were not duplicated, apparently having been the result of analytical error. However, subsequent analyses of As in other Cape Breton granitoid rocks have averaged 2-5 ppm, with scatter up to 15 ppm, further suggesting that the data in this report are too high.

PRECISION

Precision was tested by including internal standards CG-1 (granite) and CB-1 (basalt) with every batch of samples at CLIM. The statistical data for these replicate analyses are shown in Tables B-3 and B-4. In general, the major oxides have small standard deviations, with coefficients of variation less than 10 per cent, whereas trace elements have larger standard deviations and coefficients of variation between 5 and 20 per cent. The smaller the concentration of an element or oxide, the less precise is its determination. However, some determinations appear to be reasonably precise even in small concentrations (e.g. U, Mo, Sn).

As a further test on precision, 11 samples were renumbered and submitted in a later batch. Each duplicate pair of analyses was compared and the difference expressed as a percentage of the mean. The average and standard deviation of these percentage values for each oxide/element are compiled in Table B-5. They indicate that the actual precision of the analytical data varies considerably, but that only large and consistent differences should be viewed to be reliable.

An additional test on the precision is provided by the fact that in general large numbers of samples for each phase of each pluton were analyzed and these data show good internal consistency. In no case are major interpretations based on a single analysis.

Table B-1. Reference standard SY-2. Comparison of accepted values with data obtained at CLIM (Technical University of Nova Scotia)

	Recommended Value	CLTM Mean	Std. Dev.	C.V.%	n
SiO_2	60.09	60.02	0.43	0.7	12
TiO_2	0.15	n.a.	-	-	-
Al_2O_3	12.15	12.18	0.24	2.0	15
Fe_2O_3T	6.29	6.22	0.16	2.7	10
FeO	3.55	3.48	0.05	1.4	7
MnO	0.32	0.31	0.01	1.7	10
MgO	2.69	2.61	0.23	8.2	15
CaO	8.00	8.08	0.38	4.7	15
K_2O	4.51	4.47	0.11	2.4	13
Na_2O	4.35	4.46	0.27	6.0	14
P_2O_5	0.44	n.a.	-	-	-
As	18?	15	3	20	12
Ba		n.a.			
Cu	4	1	-	-	11
F	500	457	40	8	6
Mo	n.a.	1	0.33	82	4
Pb	86	86	5	7	10
Rb	220	230	5	2	10
S	100	100	-	-	2
Sn	5	6	0.66	10	4
Sr		n.a.			
Zn	250	251	14	6	10
B	-	n.a.			
Be	-	n.a.			
Bi	-	n.a.			
Co	10?	5	1	20	3
Li	90	96	2	2	3
Ni	10	4	1.4	35	3
Sb	-	n.a.			
Y	-	n.a.			
Zr	-	n.a.			

n.a. = not available

Table B-2. Reference standard SY-3*. Comparison of accepted values with data obtained at CLIM (Technical University of Nova Scotia).

	Recommended Value	CLIM Mean	CLIM Std. Dev.	CLIM C.V.%	CLIM n
SiO_2	59.68	59.67	0.75	1.3	8
TiO_2	0.15	0.15	-	9.4	2
Al_2O_3	11.80	11.62	0.25	2.1	8
Fe_2O_3T	6.40	6.43	0.14	2.2	8
MnO	0.33	0.32	0.01	1.3	8
MgO	2.64	2.56	0.01	1.7	8
CaO	8.26	8.14	0.29	3.5	8
K_2O	4.24	4.26	0.25	6.0	8
Na_2O	4.15	4.22	0.11	2.7	8
P_2O_5	0.54	n.a.	-	-	8
As	1?	3	1	33	7
Ba	440	466	20	4	3
Cu	17	14	5	33	16
F		n.a.			
Mo	n.a.	2	0.91	57	8
Pb	130	140	4	3	10
Rb	210	225	6	4	16
S		n.a.			
Sn	6	5	0.5	9	5
Sr	300	306	2	1	3
Zn	250	251	7	3	15
B	100(?)	110	16	4	6
Be	19	20	3	11	7
Bi	-	0.1	0.04	44	6
Co	12	10	-	-	2
Li	90	60	-	-	2
Ni	11	5	-	-	2
Sb		n.a.			
Y	740	730	54	7	7
Zr	340	317	19	2	7

n.a. = not available

* except As, which is for reference standard MRG-1.

Table B-3. Internal standard CG-1. Precision data.

	n	Mean	S.D.	Max.	Min.	Variance	C.V.(%)
SiO_2	33	67.63	0.83	70.4	65.81	0.69	1.23
TiO_2	11	0.84	0.05	0.92	0.77	0.00	5.31
Al_2O_3	33	15.22	0.41	16.16	14.03	0.17	2.68
Fe_2O_3T	32	5.27	0.20	5.63	4.85	0.04	3.72
FeO	25	4.38	0.28	5.47	4.01	0.08	6.30
MnO	13	0.07	0.01	0.08	0.06	0.00	9.40
MgO	31	1.58	0.13	1.81	1.04	0.02	8.06
CaO	32	2.82	0.20	3.19	2.12	0.04	7.22
K_2O	32	2.99	0.13	3.43	2.73	0.02	4.43
Na_2O	33	3.32	0.23	3.75	2.56	0.06	7.05
P_2O_5	19	0.29	0.03	0.33	0.24	0.00	9.93
As	10	8.9	2.4	13	7	5.8	27
Ba	22	721	63	820	610	3988	9
Cu	22	18	2	23	15	5.7	13
F	13	640	90	860	560	0.0	14
Mo	23	1.8	0.3	2.6	1.4	0.1	17
Pb	19	20	5	27	9	21.5	24
Rb	28	122	15	154	89	223	12
S	21	460	60	550	300	0.0	13
Sn	17	3.1	0.6	4.0	2.2	0.4	19
Sr	20	202	13	230	182	163	6
U	8	2.5	0.1	2.7	2.4	0.0	4
Zn	24	73	3	82	67	11	5
B	20	10.5	2.5	13.5	1.9	6.4	24
Be	19	2.4	0.6	4.4	1.7	0.4	26
Bi	21	0.1	0.1	0.2	0.0	0.0	69
Co	9	10	2	13	7	3.6	19
Li	10	49	4	56	41	18.9	9
Ni	7	14	2	17	13	2.3	11
Sb		n.a.					
Y	19	42	8	61	30	57.7	18
Zr	19	258	63	375	180	3965	24

n.a. = not available

Table B-4. Internal standard CB-1. Precision data.

	n	Mean	S.D.	Max.	Min.	Variance	C.V.(%)
SiO_2	33	51.13	1.07	53.3	48.19	1.14	2.09
TiO_2	8	1.21	0.14	1.50	1.05	0.02	11.72
Al_2O_3	32	14.65	0.34	15.34	14.07	0.12	2.32
Fe_2O_3T	33	10.12	0.33	10.74	9.37	0.11	3.27
FeO	29	5.97	0.20	6.66	5.59	0.04	3.29
MnO	13	0.17	0.01	0.18	0.16	0.00	3.94
MgO	33	6.78	0.39	7.55	5.69	0.16	5.80
CaO	33	9.61	0.31	10.27	8.91	0.10	3.25
K_2O	30	1.25	0.07	1.43	1.14	0.01	5.91
Na_2O	31	2.19	0.18	2.60	1.86	0.03	8.09
P_2O_5	20	0.17	0.04	0.24	0.12	0.00	23.32
As	5	6	2	8	4	1.6	32
Ba	19	204	26	242	158	671.6	13
Cu	27	412	16	450	375	258.0	4
F	13	440	210	770	200	0.0	47
Mo	23	1.9	0.4	2.6	1.0	0.2	21
Pb	17	5	3	14	2	11.6	63
Rb	25	22	2	26	18	4.1	9
S	24	150	30	200	90	0.0	22
Sn	17	1.3	0.4	2.3	0.7	0.1	29
Sr	19	178	14	203	155	188.6	8
U	8	0.4	0.1	0.5	0.3	0.0	21
Zn	24	103	5	114	88	28.3	5
B	14	8.8	0.9	10	7	0.8	10
Be	19	2.2	0.8	3.9	1.1	0.6	35
Bi	13	0.1	0.0	0.2	0.0	0.0	56
Co	9	41	2	44	38	3.6	5
Li	8	10	2	14	8	3.0	17
Ni	8	64	6	75	58	32.8	9
Sb	12	5.2	0.8	6.5	4.0	0.7	16
Y	15	35	8	50	22	69.1	24
Zr	21	111	27	164	70	750.0	25

Table B-5. Statistical data derived from 11 samples analyzed in duplicate. The mean and standard deviation of the differences between each oxide/element in each sample pair are listed. This mean gives an approximation to the error limits on each oxide/element.

	Mean (%)	Std. Dev.
SiO_2	1.0	0.9
TiO_2	13.8	9.5
Al_2O_3	3.2	2.4
Fe_2O_3T	24.3	21.7
FeO	11.0	15.1
MnO	20.1	16.7
MgO	8.7	11.8
CaO	22.3	21.3
K_2O	7.7	9.3
Na_2O	11.3	22.9
P_2O_5	23.7	25.6
As	n.a.	n.a.
Ba	16.8	13.4
Cu	29.3	24.8
F	49.8	31.9
Mo	37.4	18.4
Pb	41.7	34.4
Rb	17.6	20.1
S	65.2	58.3
Sn	18.4	28.8
Sr	18.5	17.8
Zn	10.7	9.3

n.a. = not available

APPENDIX C

PETROGRAPHIC DESCRIPTIONS OF ANALYZED SAMPLES

Samples are grouped by phase for each pluton. Each group is listed in numerical sequence.

Rock names follow the IUGS system (Streckeisen, 1976). Plots of modal Quartz - K-Feldspar - Plagioclase for each pluton are presented in the appropriate section of the text of this report.

ABBREVIATIONS USED

Major Minerals:

Q Quartz
Ks Potassium Feldspar
Pl Plagioclase Feldspar
Bi Biotite
Hb Hornblende
Py Pyroxene
Ms Muscovite
tr trace

Ks (Identification of Potassium Feldspar):

O Orthoclase
M Microcline
S Sanidine
P Perthitic

Plagioclase Composition:

% An component

Assessories:

O Opaques
A Apatite
S Sphene
Z Zircon

X = normal amounts for a rock of this type

O = more abundant than usual in a rock of this type

Grain Size, Texture:

f.g. Fine grained
m.g. Medium grained
c.g. Coarse grained
All. Gr. Allotriomorphic Granular
Hyp. Gr. Hypidiomorphic Granular
Pan. Gr. Panidiomorphic Granular
Oph. Ophitic
SOph. Subophitic
Porph. Porphyritic

Alteration:

C Carbonate
Cl Chlorite
E Epidote
H Hematite
S Saussuritite
Sc Sericite

s = slight
m = moderate
i = intense

Table C-1. Huntington Mountain Pluton: Dioritic Complex (n = 21).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1530	Diorite	2		53	5	40			38	X				c.g. Hyp.Gr.		m			m		
F16C-1535	Diorite			50		15	35		42	X				m.g. SOph.		s					
F16C-1537	Quartz Monzodiorite	5	10	60		25		OP		X	O	X		c.g. Hyp.Gr.		s	s		i		
F16C-1540	Quartz Monzodiorite	10	15	40		33		O		X	X			c.g. Porph.		s			s		2% accessories
F16C-1542	Diorite			60		25	15			X				c.g. Hyp.Gr.		m			i		
F16C-1544	Quartz Diorite	5		63	2	30			38	O				c.g. SOph.		s			i		3% opaques & accessories
F16C-1545	Diorite			45		50	5			X		X		c.g. Hyp.Gr.		m	s		i		
F16C-1549	Quartz Diorite	5	2	40		50		OP	40	X		X		c.g. Hyp.Gr.		s			m		3% opaques & accessories
F16C-1553	Quartz Diorite	2		30		65			40	X		X		m.g. All.Gr.		s			i		3% opaques & accessories
F16C-1555	Diorite			65		35				X				c.g. Hyp.Gr.							
F16C-1585	Diorite			60		15	25		35-42	X				c.g. Hyp.Gr.		s			s		
F16C-1587	Diorite			50		35	15			X		X		c.g. Hyp.Gr.		s			m		
F16C-1590	Diorite													Porph.					m		
F16C-1597	Diorite			50		50								c.g. SOph.							
F16C-1634	Quartz Monzodiorite	5	10	47		38			36					c.g. Hyp.Gr.		m			i		
F16C-1637	Diorite			62			35			O				m.g. SOph.		m			m		3% opaques & accessories
F16C-1751	Diorite			65		35								m.g. SOph.							
F16C-1760	Diorite			55		40				X				c.g. Hyp.Gr.		m			m		5% opaques & accessories
F16C-1761	Diorite			50		50								c.g. Hyp.Gr.		s			m		
F16C-1785	Quartz Monzonite	10	30	43	5	12		OP		O				c.g. Hyp.Gr.		s			i		
F16C-1788	Diorite			60		15	25							m.g. SOph.							

Table C-2. Huntington Mountain Pluton: Porphyritic Quartz Monzonite (n = 3).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1561	Quartz Monzonite	14	28	52	5			O	32	O				m.g. Porph.		i			m		1% opaques & accessories
F16C-1566	Quartz Monzonite	15	35	45	<5			O	30	X				f.g. Porph.		i	m			i	
F16C-1613	Quartz Monzonite	14	36	45	<5			OP	26	X				c.g. Porph.		m			s		

Table C-3. Huntington Mountain Pluton: Biotite Granite and Leucogranite (n-13).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1526	Granite	30	30	30		8		OP	30	X				m.g. Porph.		m	m		m		Minor graphic intergrowths
F16C-1529	Leucogranite	34	42	20	<5			OP	30	X	X			c.g. All.Gr		i		i			
F16C-1538	Leucogranite	40	32	22	<5			OP	24	X				m.g. All.Gr.		s	s	i	s		1% accessories
F16C-1539	Leucogranite	32	35	28	<5			O		X				m.g. Porph.		i		m	s		Granite porphy. dyke intruding diorite
F16C-1550	Leucogranite	35	40	22	<5			OP	25					c.g. All.Gr.		i		m	m		
F16C-1558	Leucogranite	32	40	25	<5			OP	30	X	X			c.g. All.Gr.		i	s	i	m		
F16C-1568	Leucogranite	45	35	15	<5			OP		X	X			c.g. All.Gr.		i		i			Granite dyke intruding Fourchu Group
F16C-1578	Granite	24	32	35	8			O	35	X				c.g. Hyp.Gr.		m	s	s	m		1% accessories
F16C-1582	Granite	30	34	30	6			O	29	X		X		c.g. All.Gr.		i		i			
F16C-1598	Leucogranite	32	41	23	<5			OP	28	X	X			c.g. All.Gr.		m		m	m		
F16C-1615	Granite	38	31	25	6			OP		X				c.g. All.Gr		i	m				
F16C-1618	Leucogranite	42	32	21	<5			OP	28					c.g. All.Gr.		i		i			
F16C-1776	Leucogranite	30	38	26	<5			OP	25					c.g. All.Gr.		i	s	i	m		

Table C-4. Huntington Mountain Pluton: Graphic Granite (n = 4).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1605	Graphic Granite	30	40	25	5			OP			X			c.g.		i					Abundant graphic intergrowths of quartz and feldspar
F16C-1631	Graphic Granite	22	34	40	4			OP	30	X	X	X		c.g. All.Gr.		i	s			s	
F16C-1635	Graphic Granite	35	32	2[illegible]	<5			OP	30	X				m.g. Porp.		m			m		
F16C-1782	Graphic Granite	29	35	29	<5			OP	28	X				c.g.		i			m		

Table C-5. Kellys Mountain Pluton: Dioritic Complex (n = 13).

Sample Number	Rock Name	Major Minerals						Plag. Comp.	Accessories				Grain Size,	Alteration						Comments*
		Q	Ks	Pl	Bi	Hb	Py	Ks (An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K2-1013	Qtz. Monzodiorite	10	15	60	15			O	25-30	X	X	X	X	c.g. All.Gr.		s			s		Interstitial qtz.
K7-1031	Granodiorite	20	13	55	12			P	30-35	X		X	X	c.g. All.Gr.		m			m	m	Interstitial qtz.
K7-1040	Granodiorite	30	18	52		16		O		X	X	O		m.g.Hyp.Gr.		i	s		i	m	Interstitial qtz.
K2-1093	Monzodiorite	2	F5	41		52				X		O		m.g.Hyp.Gr.		s	s		m		Poikilitic hornblende
K2-1095	Qtz. Diorite	11	3	52		33			35	X		O		m.g.Hyp.Gr.		m			m		1% Sphene
K2-1109	Tonalite	16	3	51		30			35-45	X		X		m.g.All.Gr.		i	m		i		
K8-1116	Granodiorite	13	6	46		35			30-35	X		O		m.g.Hyp.Gr.		i			i		Interstitial qtz.
K7-1125	Qtz. Monzodiorite	7	8	31		54		O		X	X	X		m.g.Hyp.Gr.		i			i		Poikilitic interstitial qtz.
K7-1130	Qtz. Diorite	6	0	49	2	43			30-40	X	X	O		m.g.Hyp.Gr.		m			s		Fresher than most
K7-1137	Qtz. Monzodiorite	3	15	42		15	25			O				f.g. intergran.		i			i		May be diabase dyke?
K7-1212	Qtz. Monzodiorite	7	9	41		43				X	X			m.g. All.Gr.		i	m		i		Interstitial qtz.
K7-1220	Qtz. Monzodiorite	6	8	46	5	35		O	37-45	X	X	O	X	c.g. All.Gr.		m			m		Interstitial qtz.
K7-1231	Qtz. Diorite	4	4	48		44			40-50	X	X	X	X	f.g.Hyp.Ineq.		s			s		Variable grain size and texture

*zoned plag. in all samples.

Table C-6. Kellys Mountain Pluton: Biotite Granodiorite (n = 5).

Sample Number	Rock Name	Major Minerals						Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks (An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K2-1090	Granodiorite	24	16	56	4			P		X	X		X	c.g.Hyp.Gr.		s			s		Interstitial quartz
K7-1204	Granodiorite	33	17	45	5			P	20-25	X	X	X	X	m.g.Hyp.Gr.		m			m		Interstitial quartz
K7-1206	Granodiorite	36	18	42	4			P	20-25	X	X		X	m.g.Hyp.Ineq.		m	s		m		Interstitial quartz
K7-1207	Granodiorite	35	20	40	3			P	20-25	X			X	m.g.Hyp.Ineq.		m			s	m	
K7-1208	Granodiorite	28	20	47	5			P		X		X		m.g.Hyp.Gr.		s			s	s	

Table C-7. Kellys Mountain Pluton: Leucogranite (n = 28).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
K7-1027	Granite	34	40	25	1			P	15-20	X	X		X	c.g. All.Gr.		s		s	s		
K7-1056	Granodiorite	37	22	40	1			P	15-20	X				m.g. All.Gr.		m		s	m		
K8-1063	Granite	40	35	25	<1			P	~10	X				c.g. All.Gr.		m			m		
K1-1067	Granite	29	42	29	<1			P	12-15	X				c.g. All.Gr.		m		s	s	s	
K8-1072	Granite	38	37	25	<1			P	10-12	O				c.g. All.Gr.		i	s		m	m	Relatively abundant epidote, opaques
K8-1084	Granite	38	34	28	<1			P	10-15	O				c.g. All.Gr.		i	s		m	m	Similar to 1072
K8-1085	Granite	40	34	26	1			P	5-20	X			X	c.g. All.Gr.		s			s	s	Fresh biotite, zoned plagioclase
K2-1108	Granite	35	27	38	<1			P	10-15	X				c.g. All.Gr.		i	s		m	m	
K2-1110	Granite	42	25	31	2			P	15-20	X		X	X	c.g. All.Gr.		m			m	s	Zoned plagioclase
K8-1111	Granite	39	35	26	<1			P	10-15	X			X	c.g. All.Gr.		s			s	s	Fresh biotite
K8-1117	Granite	39	28	33	<1			P	5-15	X				c.g. All.Gr.		i			m	i	
K8-1120	Granite	38	35	27	<1			P	5-20	X			X	c.g. All.Gr.		s			s	s	Fresh biotite, zone plagioclase
K7-1134	Granite	42	35	23	<1			P	15-20	O				c.g. All.Gr.		i	s	s	m	m	
K7-1140	Granodiorite	46	18	35	<1			O	15-20	O	X		X	c.g. All.Gr.		m	s	s	m	m	
K8-1148	Granite	40	21	36	3			P	10-15	O				c.g. All.Gr.		i	s		m	m	Relatively abundant mafic minerals
K8-1150	Granite	30	37	33	<1			P	10-15	X				c.g. All.Gr.		m		s	m	m	
K8-1152	Granite	40	35	25	<1			P	12-20	X				c.g. All.Gr.		i			m	m	
K8-1153	Granite	32	28	40	<1			P	10-15	X				m.g. All.Gr.		m		s	s	s	
K8-1156	Granite																				Data not available
K8-1160	Granite	40	25	35	<1			P	10-15	X				c.g. All.Gr.		m	s	s	m	s	
K8-1167	Granite	30	28	41	1			P	12-20	X				m.g. All.Gr.		m	m		s	m	Zoned plagioclase
K8-1178	Granite	33	34	32	1			P	10-15	X				m.g. All.Gr.		i	m		s	s	
K8-1185	Granite	37	33	30	<1			P	10-15	X				m.g. All.Gr.		i	m		s	m	
K7-1194	Granite	35	38	27	<1			P	10-15	X				c.g. All.Gr.		m			s	s	
K8-1198	Granodiorite	47	17	36	2			P	10-20	O				c.g. All.Gr.		i			m	m	Zoned plagioclase
K7-1210	Granite	38	30	30	2			P	10-15	X				m.g. All.Gr.		m			s	s	
K8-1224	Granite	37	38	25	<1			P	10-15	X				c.g. All.Gr.		m	s		s	s	
K8-1227	Granite	28	30	42	<1			P	10	X				m.g. All.Gr.		m			m	s	Granophyric texture

Table C-8. Kellys Mountain Pluton: Fine Grained Leucogranite (n = 8).

Sample Number	Rock Name	Major Minerals							Plag. Comp	Accessories				Grain Size,	Alteration					Comments*
		Q	Ks	Pl	Bi	Hb	Ms	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K2-1009	Granite	25	39	36	<1			M	≈10	X	X		X	f.-m.g.All.Gr.					s	s	
K8-1076	Granite	25	56	19	<1			P	<10	X	X			f.-m.g.All.Gr.		m			m		
K7-1128	Granite	30	30	40	1					O				f.g.Hyp.Gr.		i			m		Abundant interstitial graphic intergrowths
K7-1141	Granite	30	39	30	<1			M	<10	X				m.g.All.Gr.		m			m		
K8-1149	Granite	30	33	37	1		<1	P	<10	X				f.-m.g.All.Gr.		i			s	s	
K8-1171	Granite	35	38	27	<1		<1	O	<10	X				m.g.All.Gr.		i			m	m	Abundant coarse graphic intergrowths
K8-1173	Granite	32	37	31	<1		<1	O	<10	X				m.g.All.Gr.		i			m	m	Abundant coarse graphic intergrowths
K8-1223	Granite	32	26	42	<1		<1	O	<10	X				m.g.All.Gr.		i			m	m	Abundant coarse graphic intergrowths

*normal zoning is common in plagioclase

Table C-9. St. Anns Mountain Pluton: Hornblende Granodiorite and related rock types (n = 11).

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K7A-1517	Granodiorite	18	17	33	5	25		OP	35	X				c.g.All.Gr.		s			m		2% accessories + opaques
K7A-1534	Granodiorite	23	10	50		15		OP		X		X		c.g.Hyp.Gr.		s			m		
K7A-1561	Quartz Monzodiorite	8	10	58		22		OP		X		X		c.g.Hyp.Gr.		i	m	m	i		2% accessories + opaques
K7A-1566	Granodiorite	15	12	35		38		OP	42	X				c.g.Hyp.Gr.		s			s		
K7A-1574	Quartz Monzodiorite	8	5	40		45		O	40	X		X		c.g.Hyp.Gr.		s			i		2% accessories + opaques
K7A-1621	Quartz Monzodiorite	5	20	55		18		O		X		X		c.g.Hyp.Gr.		s		i	i		2% accessories + opaques
K7A-1631	Tonalite	20		55		22				X				c.g.Hyp.Gr.	i	i	i		i		3% accessories + opaques
K7A-1642	Quartz Diorite	10		42		45				X		X		m.g.Hyp.Gr.	m	i	s		i		3% accessories + opaques
K7A-1645	Quartz Monzonite	15	30	40		15		OP		X				c.g.All.Gr.	i	i		m	i		
K7A-1765	Granodiorite	15	10	35		40		O	38	X		X		c.g.Hyp.Gr.		i			m		
K7A-1811	Quartz Diorite	10	5	50		35				X				c.g.Hyp.Gr.		s			m		

Table C-10. St. Anns Mountain Pluton: Hornblende Biotite Granite and Granodiorite (n =11).

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K7A-1514	Quartz Monzonite	15	30	40	5	10		OP	32	X		O		c.g.All.Gr.		s		s			
K7A-1550	Granite	30	28	35	<5	<5		OP	30	X				c.g.Hyp.Gr.		s		s	m		
K7A-1584	Granodiorite	20	15	50	6	8		O		X		O		c.g.Hyp.Gr.		s	m		s		1% opaques
K7A-1589	Granodiorite	25	10	45	5	15		O		X				c.g.Hyp.Gr.		i				a	
K7A-1605	Granodiorite	30	12	48	<5	14		O	35	X		X		c.g.Hyp.Gr.		i	i			m	1% accessories
K7A-1618	Granite	20	30	40	8	<5		OP	33	X				c.g.Hyp.Gr.		i	i		m	m	
K7A-1619	Granite	20	28	35	10	<5		OP	28	X		X		c.g.All.Gr.		s	s		m		2% accessories
K7A-1620	Quartz Monzonite	14	32	38	8	8		OP	30	X		O		c.g.Hyp.Gr.		s			s		
K7A-1756	Granite	23	30	30	5	10		OP	30	X		X		c.g.All.Gr.		m			m		2% accessories
K7A-1773	Granodiorite	28	14	40	5	10		O		X		X		c.g.Hyp.Gr.		m	i		i		1% accessories
K7A-1804	Granite	25	28	34	8	5		O	32	X		X		c.g.All.Gr.		s			s		

Table C-11. St. Anns Mountain Pluton: Biotite Granite, Leucogranite, and Porphyritic Granite (n =13).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration					Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc
K7A-1500	Leucogranite	30	40	24	<5			OP	25	X				c.g.Hyp.Gr.		m	s	m	m	1% accessories
K7A-1507	Granite	33	32	30	5			OP		X	X			c.g.All.Gr.		i		m	m	
K7A-1515	Leucogranite	36	32	26	<5			O	24		X			c.g.All.Gr.		i		m	m	1% accessories
K7A-1546	Leucogranite	32	40	25	<3			OP	24	X	X			c.g.All.Gr.		i		m		
K7A-1548	Granite	20	44	30	5			OP	30	X	X	X		c.g.Hyp.Gr.		i		s	s	1% accessories epidote + opaques
K7A-1555	Leucogranite	40	34	22	<5			OP	26	X				m.g. Porph.	s	i		s		
K7A-1567	Granite	35	30	30	5			OP	30	O	X			m.g. Porph.		i	s	m	m	
K7A-1570	Leucogranite	35	40	20	<5			OP	30	X				c.g.All Gr.		i	m	m		
K7A-1610	Leucogranite	30	34	30	<5			OP	24	X	X			m.g. Porph.		i		i	m	1% accessories
K7A-1625	Granite	38	34	20	8			OP		X	X			c.g.All.Gr.		m		m	m	May be a dyke or small plug of leucogranite. Relationship not exposed.
K7A-1795	Leucogranite	30	37	28	<5			OP	28	X				c.g.All.Gr.		m		m	m	
K7A-1796	Granite	30	34	30	6			OP	27	X	X			c.g.All.Gr.		i		m	m	
K7A-1812	Leucogranite	32	35	28	<5			OP	28	X				c.g.All.Gr.		m	s	m	m	

Table C-12. St. Anns Mountain Pluton: Quartz Diorite, Granodiorite, and Tonalite (n = 5).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration					Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc
1501	Tonalite	15		50		25				O				c.g. Porp.		i	i			Purple porphyritic dyke intruding leucogranite.C.g. phenocrysts of Pl, Hb, Cl. M.g. ground mass. Some quartz in ground mass. For 1501 and 1505 10% is chlorite and opaques.
1505	Tonalite	15		55		20			38-40	O				c.g. Porp.		i	i			
1525	Quartz Diorite	<5		45		40				X				c.g. Porp.		s	i			Fine grained ground mass, 10% opaques, chlorite and accessories.
1575	Quartz Diorite	8		50		38				X				m.g.Hyp.Gr.		i	m			Hornblende extensivly altered to chlorite. 4% accessories and opaques.
1601	Granodiorite	15	15	40		30				O				m.g.Hyp.Gr.		s	m		i	Orthoclase found as interstitial fillings. 5% opaques, epidote and accessories.

Table C-13. St. Anns Mountain Pluton: Porphyritic Quartz Monzonite (n = 4).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
K7A-1520	Quartz Monzonite	18	35	40	5				32					f.g. Porph.	s	i	i	s	s		2% epidote
K7A-1537	Quartz Monzodiorite	15	25	55					28					f.g. Porph.		i	i	m	s		5% are opaques
K7A-1627	Quartz Monzonite-granite													f.g. Porph.			i				Too f.g. for modal analyses
K7A-1634	Quartz Monzonite	15	30	45	10				34					m.g. Porph.		i	i				

Table C-14. Cape Smoky Pluton: Quartz Diorite, Granodiorite, and related rock types (n = 7).

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K9B-1500	Granodiorite	15	10	50		25		M	35	X		X		c.g.Hyp.Gr.		s	m		m		
K9B-1524	Qtz. Diorite	12		55	<3	30			34	X		X		c.g.Hyp.Gr.		m	s		m		
K9B-1530	Qtz. Diorite	6		50		44				O		X		c.g.Hyp.Gr.		s			m		
K9B-1556	Qtz. Monzodiorite	10	F5	45		40		M	35	X		X		c.g.Hyp.Gr.		m	m		m		
K9B-1574	Qtz. Diorite	10		55		35			36	X				c.g.Hyp.Gr.		i	i		i		
K9B-1575	Qtz. Diorite	12		47		38			35	O		X		c.g.Hyp.Gr.		s			s		
K9B-1756	Granodiorite	15	7	50	<3	25		M	35	X				c.g.Hyp.Gr.		m	m		m		

Table C-15. Cape Smoky Pluton: Granodiorite and variants (n = 5).

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K9B-1533	Qtz. Monzodiorite	15	20	45	8	12		M	24	X				c.g.Hyp.Gr.		s			s		
K9B-1537	Granodiorite	20	20	40	10	10		M	28	X		X		c.g.Hyp.Gr.		s	m		m		
K9B-1538	Granite	27	32	36	5			M		X				c.g.All. Gr.		m			m		
K9B-1578	Granodiorite	18	22	45	10	5		M	29	X				c.g.Hyp.Gr.		s	s		s		
K9B-1579	Granite	25	25	40	10			M	26	X				c.g.Hyp.Gr.		m	s		m		Gradational with 1578

Table C-16. Cape Smoky Pluton: Biotite Granite (n = 34).

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
K98-1503	Granite	32	25	32	10			M	22	X		X		c.g.Hyp.Gr.		s			s		
K98-1509	Leucogranite	40	34	22	4			M	26	X	X			c.g.All.Gr.		m	s		i	m	
K98-1511	Granite	18	30	35	15			M	28	O				c.g. Porph.		i	i		m		
K98-1512	Granite	26	32	32	10			OP		X				c.g. Porp.		s			s		Deformed biotite grains
K98-1515	Granite	35	35	25	5			M	25	X	X			c.g.Hyp.Gr.		s			s		Foliated
K98-1529	Granite	40	35	20	5			M	26	X	X			m.g.All.Gr.		m					
K98-1542	Granite	35	35	22	8			M	22					c.g.All.Gr.		s			s		Foliated and fragmented mosaic qtz.(recryst.)
K98-1543	Granite	34	36	23	7			M	24	X				c.g.All.Gr.		s			s		Deformed
K98-1551	Granite	30	32	30	8			M	22	X	X			c.g.All.Gr.		s			s		Deformed
K98-1555	Granite	25	28	32	14			OP	28	X		X		c.g.Hyp.Gr.		s			s		Slightly deformed
K98-1557	Granite	25	25	35	15			M	28	O		X		c.g.Hyp.Gr.		m			m		Somewhat porphyritic
K98-1559	Granite	25	32	32	10			M	26	X		X		c.g.Hyp.Gr.		m			m		
K98-1561	Qtz.Monzonite	15	28	39	16			M	28	X		X		c.g.Hyp.Gr.		m			m		Gradational with granite
K98-1563	Granite	30	35	30	5			M	22	X				c.g.All.Gr.		s			s		Contains minor muscovite
K98-1564	Granite	28	33	30	8			M	23	X				c.g.All.Gr.		m			m		
K98-1565	Granite	36	36	20	8			M	22					c.g.All.Gr.		m			m		
K98-1566	Granite	28	30	35	7			M	24	X	X			c.g.All.Gr.		s			s		Moderately deformed
K98-1568	Leucogranite	35	35	25	<5			M	24	X	X			c.g.All.Gr.		s			s		Slightly deformed
K98-1571	Granite	30	35	30	5			M	25	X				c.g.All.Gr.		s			s		Moderately deformed. Weak foliation.
K98-1572	Leucogranite	32	35	28	<5			M	23					c.g.All.Gr.		s			s		Moderately deformed. Weak foliation.
K98-1573	Granite	30	31	30	9			M	23	X				c.g.All.Gr.		m			m		Moderately deformed
K98-1576	Granite	24	28	38	10			M		X				c.g.Hyp.Gr.		s			s		
K98-1577	Granite	24	25	36	14			M	25	X				c.g.Hyp.Gr.		s			s		
K98-1580	Granite	32	30	30	8			O	24	X				c.g.All.Gr.		s			s		
K98-1581	Granite	30	28	36	6			O	28	X				m.g.All.Gr.		s			s		Slightly deformed
K98-1584	Granite	32	35	28	5			M	26	X				m.g.All.Gr.		s			s		Slightly deformed
K98-1585	Granite	30	32	30	7			M	27	X	X	X		c.g.All.Gr.		s			s		
K98-1586	Granite	30	34	28	7			M		X				m.g.All.Gr.		m			m		
K98-1750	Granite	35	30	25	8			M		X				c.g.All.Gr.		s			s		
K98-1754	Granite	33	30	30	7			M	28	X				c.g.All.Gr.		s			s		
K98-1760	Granite	35	35	25	5			M	24	X	X			c.g.All.Gr.		m			m		
K98-1763	Leucogranite	35	38	22	<5			M	24	X				c.g.All.Gr.		s			s		
K98-1764	Granite	32	34	26	8			M	28	X	X			c.g.All.Gr.		s			s		Slightly deformed
K98-1769	Granite	36	30	25	8			M	27	X				c.g.		s			s		Moderately deformed

Table C-17. White Point Pluton: Granodiorite (n = 5) and Foliated Granodiorite (K16-1009).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments*
		Q	Ks	Pl	Bi	M	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
K16-1009	Granodiorite	18	17	55	10		<1		25-50		X	O	X	c.g.All Gr.		s					Py. replaced by biotite. Zoned plag.
K16-1016	Granite	23	27	46	3	1		M?	15-20					m.g.All Gr.		s			s		Interstitial myrmekite
K16-1026	Granite	34	22	38	5	1		M	15-20	X	X		X	m.g.All.Gr.					s	s	Minor myrmekite
K16-1045	Granite	35	20	35	8	<1			15-20	X	X			f.-m.g.All.Gr.					s		Minor myrmekite
K16-1094	Granodiorite	35	20	39	5	<1		M	15-20	X	X		X	f.-m.g.All.Gr.		s			s	s	Minor myrmekite
K16-1111	Granodiorite	30	10	49	10	<1			15-20	X	O		X	f.-m.g.All.Gr.		s			s	s	Very minor myrmekite

*Plagioclase commonly shows normal zoning. Quartz shows undulatory extinction.

Table C-18. White Point Pluton: Granite (n = 32).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Ms			O	A	S	Z		C	Cl	E	H	S	Sc	
K16-1002	Granite	36	28	33	-		3	M	25					m.g.All.Gr.					s	s	Garnet <1% pegmatoid/ aplitic patches
K16-1023	Granite	35	44	20	<1		<1	M	20					m.g.All. Ineq.Gr.		m		s			Interstital myrmekite
K16-1029	Granite	30	29	37	3		3	M	20				X	m.g.All. Ineq.Gr.					s		Quartz inclusions in feldspars
K16-1032	Granite	27	27	43	1		2	M	15				X	m.g.All.Gr.					s		Rare garnet.
K16-1038	Granite	34	35	27	2		2	M	20				X	m.g.All.Gr.		m			s		Quartz inclusions in feldspars
K16-1040	Granite	27	34	37	2		2	M	15-20					m.g.All.Gr.					s	s	Minor interstital myrmekite, qtz. inclusions
K16-1043	Granite	23	33	40	4		<1	M	15-20		X		X	m.g.All. Ineq.Gr.					s		
K16-1049	Granite	37	43	17	3		<1	M	15		X		X	m.g. All. Ineq. Gr.		s			s	s	Interstial myrmekite
K16-1051	Granite	25	33	37	4		1	M	20				X	m.g.All.Gr.					m	s	Minor interstitial myrmekite
K16-1053	Granite	24	35	39	3		3	M	20					m.g.All.Gr.					s		Interstial myrmekite
K16-1055	Granite	28	30	42	<1		<1	M	20					m.g.All.Gr.				s	s		Interstial myrmekite
K16-1061	Granite	35	24	38	2		<1	M	15-20					m.g.All. Ineq.Gr.				s	s		
K16-1064	Granite	30	50	20	<1		<1	M	20					m.g.All.Gr.				s	m		Minor myrmekite
K16-1070	Granite	30	24	44	2		<1	M	20				X	m.g.All. Ineq.Gr.				s		s	Minor myrmekite

Table C-18. Continued.

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Ms	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
K16-1072	Granite	30	34	32	2		2	M	20				X	c.g.All Gr.		m		s	s	s	
K16-1073	Granite	35	33	29	2		1	M	20				X	m.-c.g.All. Ineq.Gr.		m		s	s	s	
K16-1077	Granite	29	33	36	1		1	M	20					m.g.All.Gr.		m		s	s		Interstitial myrmekite
K16-1085	Granite	30	30	36	3		1	M	15-20		X		X	m.g.All. Ineq.Gr.		s			s		
K16-1086	Granite	32	29	36	2		1	M	12-15	X				m.g.All.Gr.		m				s	
K16-1089	Granite	35	21	40	3		1	M	12-15	X			X	f.-m.g.All.Gr.		s		s	s	s	Minor myrmekite
K16-1097	Granite	31	30	36	1		2														
K16-1098	Granite	34	31	31	2		2	M	15-20	X			X	m.g.All.Gr.		s		s	s	s	Minor myrmekite
K16-1100	Granite	31	43	25	<1		<1	M	15-20	X				f.-m.g.All.Gr.		s		m	s		Interstitial myrmekite
K16-1104	Granite	25	33	40	2		<1	M	15-20	X			X	m.g.All.Gr.		s			s		Minor myrmekite
K16-1106	Granite	28	33	36	2		1	M	15-20	X				m.g.All.Gr.				m	s		Qtz.grains fractured. Minor myrmekite
K16-1107	Granite	33	41	24	3		1	M	15-20	X	X		X	m.g.All.Gr.		s			s		Interstitial myrmekite
K16-1120	Granite	37	33	28	1		1	M	15-20				X	m.g.All.Gr.		m			s		Interstitial myrmekite
K16-1123	Granite	34	27	38	1			M	15-20	X	O			m.g.All.Gr.		s			s	s	Interstitial myrmekite
K16-1127	Granite	35	26	35	1		3	M	15-20				X	m.g.All.Gr.					s	s	Interstitial myrmekite
K16-1129	Granite	30	39	28	2		1	M	15-20		X		X	m.g.All.Gr.					s		Myrmekite very minor
K16-1131	Granite	23	36	38	2		1	M	20-25				X	m.g.All.Gr.		s				s	Myrmekite very minor
K16-1133	Granite	30	30	36	<1		3	M	15-20					c.g.All.Gr.		m			m	s	

Table C-19. White Point Pluton: Granite (Aplite) (n =2).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Ms	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
K16-1035	Granite	25	35	25		15															<1% garnet
K16-1080	Granite	25	34	26		15															<1% garnet

Table C-20. Gillis Mountain Pluton: Quartz Monzodiorite (n = 9).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture*	Alteration						Comments**
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1029	Qtz.Monzodiorite	11	12	60	15	<2	tr	S	54	X	X			Porph.		s				s	
F16C-1030	Qtz.Monzodiorite	10	15	55	12	7	<1	S	50	X	X			m.g.Hyp. Inequig.		s				s	Almost porphyritic
F16C-1046	Qtz.Monzodiorite	15	10	52	15	4	4	S	55	X	X	X		m.g.Hyp. Inequig.		s				s	Abundant f.g.biotite in patches
F16C-1066	Qtz.Monzodiorite	10	10	61	17	<2		S	55	X	X			m.g.Hyp. Inequig.		s				s	Almost porphyritic
F16C-1105	Qtz.Monzodiorite	10	10	58	5	5	12	S	54	X	X			m.g.Hyp. Inequig.		s				s	Abundant granophyre
F16C-1110	Qtz.Monzodiorite	12	14	60	9	5		S	50	X	X			Porph.		s				s	
F16C-1113	Qtz.Monzodiorite	12	14	55	7	9	3	S	56		X			Porph.		s					Subophitic patches
F16C-1129	Qtz.Monzodiorite	11	11	60	6	10	2	S	50	X	X			f.g.All. Inequig.		s				s	
F16C-1136	Qtz.Monzodiorite	7	10	65	8	10		S		X	X			m.g.All. Inequig.		m				s	

*Vary from distinctly porphyritic to seriate porphyritic to hiatal porphyritic. **Interstitial quartz (poikilitic).

Table C-21. Gillis Mountain Pluton: Porphyritic Granite (n = 28).

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments*
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1023	Granite	20	30	41	8	<<1		S	38	X	X	X	X	Porph.		s		s	m	s	F.g.granular groundmass
F16C-1033	Granodiorite	35	16	40	6	3		S	36	X	X	X	X	c.g.Hyp. Inequig.		s		s		s	
F16C-1035	Granite	30	20	40	8	<2		S	42	X	X	X	X	c.g.Hyp. Inequig.		s		s	m		
F16C-1037	Granite	29	22	40	6	1		S	38	X	X	X	X	c.g.Hyp. Inequig.		m				s	
F16C-1039	Qtz.Monzonite	16	32	42	8	2		S	39	X	X	X	X	c.g.Hyp. Inequig.		m			m	s	
F16C-1044	Granite	25	33	33	6	3		S	40	X	X		X	Porph.		s		s		s	F.g.granular groundmass
F16C-1049	Granite	25	33	33	5	4		S	38	X	X		X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1050	Granite	25	32	34	6	3		S	37	X	X		X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1051	Granite	25	30	38	5	2		S	40	X	X	X	X	Porph.		s		s	s	s	M.g.granular groundmass
F16C-1053	Granodiorite	28	21	43	5	3		S	40	X	X	X	X	Porph.		s		s	s	s	M.g.granular groundmass
F16C-1055	Granite	20	30	40	6	4		S	40	X	X	X	X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1057	Granite	22	35	35	4	4		S	40	X	X	X	X	Porph.		s		s	s	m	F.g.granular groundmass
F16C-1059	Granite	20	39	33	7	<1		S	38	X	X	X	X	Porph.		s		s	s	m	F.g.granular groundmass
F16C-1064	Granite	22	41	30	6	<1		S	35	X	X	X	X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1072	Granite	25	35	31	8	<1		S	38	X	X		X	Porph.		s		s	s	m	F.g.granular groundmass
F16C-1074	Granite	22	33	35	8	2		S	38	X	X	X	X	Porph.		s		s	s	m	F.g.granular groundmass

Table C-21. Continued.

Sample Number	Rock Name	Major Minerals						Ks	Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments*
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1075	Granite	20	30	41	7	2		S	40	X	X	X	X	Porph.		s		s	s	m	F.g.granular groundmass
F16C-1076	Granite	20	50	25	<5			S	42	X	X	X	X	Porph.		s		s	m	m	F.g.granular groundmass
F16C-1081	Granite	20	26	46	6	2		S	41	X	X	X	X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1086	Granodiorite	23	23	46	6	2		S	43	X	X	X	X	Porph.		m		s	m	s	F.g.granular groundmass
F16C-1094	Granite	20	40	35	<5			S	41	X	X	X	X	Porph.		i		s	i	i	F.g.granular groundmass
F16C-1102	Granite	20	31	43	4	2		S	37	X	X	X	X	Porph.		i		s	i	i	F.g.granular groundmass
F16C-1104	Granite	25	40	28	4	3		S	37	X	X	X	X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1111	Granite	25	38	30	4	<2		S	42	X	X	X	X	Porph.		s		s	s	s	F.g.granular groundmass
F16C-1115	Granite	20	50	23	7			S	40	X	X	X	X	Porph.		s		m	m	i	F.g.granular groundmass
F16C-1117	Granite	20	40	31	6	3		S	39	X	X	X	X	Porph.		s		m	s	m	F.g.granular groundmass
F16C-1120	Granite	25	32	35	5	3		S		X	X		X	Porph.		s		s	s	s	M.g.granular groundmass
F16C-1134	Granite																				

*All samples contain strongly zoned plagioclase. The plagioclase composition reported is an average. Porphyritic samples contain phenocrysts of plagioclase, quartz, and biotite, in order of decreasing abundance.

Table C-22. Gillis Mountain Pluton: Fine Grained granite (n = 7).

Sample Number	Rock Name	Major Minerals						Ks	Plag Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py			O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1017	Granite	35	33	25	7			S	35	X	X		X	m.g.Hyp. Inequig.		s			s	s	
F16C-1024	Granite	28	32	30	8	<2		S	37	X	X	X	X	f.g.Hyp.Gr.		s			s	s	
F16C-1043	Granite	30	31	31	7	<1		S	33	X	X	X	X	f.g.Hyp.Gr.		s			m		
F16C-1119	Granite	35	35	24	6			S	38	X	X	X	X	m.g.Hyp. Inequig.		s		s	s	s	Almost porphyritic
F16C-1124	Granite	30	32	30	7	<1		S	35	X	X	X	X	m.g.All. Inequig.		s				s	
F16C-1127	Granite	34	41	20	5			S	36	X	X		X	f.g.All. Inequig.		s				s	
F16C-1137	Granite	32	32	28	7	<<1		S	34	X	X		X	m.g.Hyp. Inequig.		s				m	Almost porphyritic

Table C-23. Gillis Mountain Pluton: Minor Phases (n = 8)

Sample Number	Rock Name	Major Minerals							Plag. Comp.	Accessories				Grain Size,	Alteration						Comments
		Q	Ks	Pl	Bi	Hb	Py	Ks	(An)	O	A	S	Z	Texture	C	Cl	E	H	S	Sc	
F16C-1026		X	X	X	X				30	X	X		X	Porph.		s				s	Plag., qtz., biotite phenocrysts
F16C-1060		X	X	X	X				36	X				m.g.All.Gr.						i	Highly altered
F16C-1061		X	X	X	X					X				m.g.All. Inequigr.						i	Highly altered
F16C-1079	Aplite	X	X	X	X					X				Aplitic		i		i	i	i	Highly altered
F16C-1083		15	10	58	12				38	X	X	X		m.g.Hyp.Gr.		m			m	s	Interstitial quartz
F16C-1088	Aplite	X	X	X	X					X				Aplitic				i	i	i	Highly altered
F16C-1091		X	X	X	X					X	X	X	X	Porph.		m		s	m	m	Similar to 1026
F16C-1116		X	X	X	X					X	X		X	Porph.		i				m	Abundant granophyre

Table C-24. Deep Cove: Granite (n = 9)

Sample Number	Rock Name	Major Minerals							Plag* Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments**
		Q	Ks	Pl	Bi	Hb	Py	Ks		O	A	S	Z		C	Cl	E	H	S	Sc	
F16C-1202	Granite	28	50	17	5					X	X		X	f.g.All. Inequig.		m				s	Abundant granophyre
F16C-1203	Granite	30	35	30	<5					X				Poph.		m				m	Very fine grained
F16C-1209	Granite	24	55	15	5	<1			25	X	X	X	X	f.g.Hyp.Gr.		m			s	s	5% Plagioclase phenocrysts
F16C-1214	Granodiorite	19	19	52	9	<1		S	30	X	X	X	X	m.g.All. Inequig.		m				m	Almost porphyritic
F16C-1216	Granite	30	29	36	5					X				Porph.							
F16C-1217	Granite	30	30	30	<10			S	32	X	X		X	m.g.All.Gr.		s				s	
F16C-1220	Granite	30	40	20	<10				34	X	X	X	X	Porph.		s				s	Plag., quartz,biotite phenocrysts
F16C-1222	Granite	35	40	20	5				25	X	X		X	Porph.		s			s	m	Plag., quartz,biotite phenocrysts
F16C-1225	Granite	30	45	20	<5				25	X	X		X	Porph.		i			i	i	Plag., quartz,biotite phenocrysts

*Average composition

**Zoned plagioclase is characteristic of these samples

Table C-25. Petit-de-Grat Pluton: Leucogranite (n = 8).

Sample Number	Rock Name	Major Minerals							Plag. Comp. (An)	Accessories				Grain Size, Texture	Alteration						Comments*
		Q	Ks	Pl	Bi	Hb	Py	Ka		O	A	S	Z		C	Cl	E	H	S	Sc	
F7/2-1000	Leucogranite	37	38	25				P	5	X				m.g.All.				s	m	m	Cataclastic texture, perthitic Or
F7/2-1001	Leucogranite	38	39	23				P	5	X				m.g.All.				s	m	m	Cataclastic texture, perthitic Or
F7/2-1003	Leucogranite	41	35	24				P	5	X				c.g.All.				s	m	m	Somewhat less cataclastic
F7/2-1004	Leucogranite	43	32	25				P	5	X				m.g.All.				s	m	m	Strongly cataclastic
F7/2-1009	Leucogranite	30	50	20				P		X				m.g.All.				s	m	m	Strongly cataclastic
F7/2-1012	Leucogranite	35	45	20				P	5-8	X				f.g.All.				s	m	m	Strongly cataclastic
F7/2-1013	Leucogranite	35	42	23				P	5	X				m.g.All.			s	s	m	i	Strongly cataclastic
F7/2-1014	Leucogranite	42	37	21		<1		P		X				c.g.All.			m	s	s	s	Somewhat less cataclastic and less altered

*All samples have a cataclastic texture, with angular broken fragments of quartz and feldspar in a granulated groundmass.

APPENDIX D

COMPILATION OF MAJOR AND TRACE ELEMENT ANALYSES AND CIPW NORMATIVE MINERALOGIES

Samples are grouped by phase for each pluton. Each group is listed in numerical sequence.

Note: W values are less than the detection limit of 4 ppm in all samples and hence are not included in the tables.

HUNTINGTON MOUNTAIN PLUTON DIORITIC COMPLEX

SAMPLE NO	F16C-1530	F16C-1535	F16C-1537	F16C-1540	F16C-1542	F16C-1544	F16C-1545	F16C-1549	F16C-1553	F16C-1555	F16C-1585	F16C-1587
SIO2	51.25	47.00	55.86	67.67	48.15	55.49	46.65	50.27	49.59	47.19	48.30	49.81
TIO2	1.40	1.67	1.90	0.79	1.60	1.97	2.14	2.22	1.55	2.67	1.84	1.94
AL2O3	16.75	18.67	16.02	14.12	22.05	17.93	17.12	16.06	17.36	15.49	19.09	17.82
FE2O3	1.13	2.00	5.98	1.80	2.52	3.40	3.85	4.59	3.12	3.94	2.22	1.99
FEO	6.35	6.48	2.70	2.42	4.13	4.23	6.76	7.36	6.13	8.15	7.27	6.93
MNO	0.15	0.19	0.25	0.10	0.13	0.24	0.20	0.20	0.17	0.22	0.18	0.17
MGO	6.11	8.12	3.23	1.52	4.64	3.32	6.62	4.98	6.03	5.10	7.40	6.55
CAO	7.84	10.08	5.18	2.99	9.61	5.52	8.97	7.78	8.21	8.90	7.76	8.85
NA2O	4.13	2.69	3.85	4.10	2.81	5.47	3.12	4.06	3.33	3.55	3.48	3.29
K2O	0.87	0.32	2.53	3.44	1.95	1.41	1.56	0.98	1.48	1.08	0.99	0.94
H2O+	3.52	2.33	1.33	0.76	1.95	1.08	2.16	1.36	1.68	1.77	1.34	1.50
H2O-	0.06	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.16
P2O5	0.20	0.15	0.43	0.18	0.20	0.42	0.32	0.36	0.32	0.44	0.30	0.23
CO2	0.02	0.10	0.43	0.09	0.07	0.05	0.27	0.15	0.05	0.10	0.14	0.04
TOTAL OXIDES	99.78	99.80	100.21	99.98	99.81	100.53	99.74	100.37	99.02	98.60	100.50	100.22
NORMATIVE MINERALOGY												
QUARTZ	----	----	10.71	22.82	----	2.90	----	0.23	----	----	----	----
CORUNDUM	----	----	----	----	----	----	----	----	----	----	----	----
ORTHOCLASE	5.35	1.94	15.22	20.46	11.78	8.33	9.44	5.85	8.93	6.53	5.86	5.64
ALBITE	36.25	23.25	33.03	34.89	24.29	46.46	27.02	34.64	28.84	30.89	29.76	28.25
ANORTHITE	25.63	38.91	19.29	10.12	42.67	20.37	28.76	22.87	28.87	23.95	33.93	31.55
DIOPSIDE	7.31	6.50	1.05	1.80	2.86	2.68	7.98	7.28	6.19	9.79	1.21	6.40
HEDENBERGITE	3.63	2.13	----	0.76	0.63	0.58	2.42	3.07	2.20	4.89	0.50	2.80
ENSTATITE	6.28	7.00	7.69	2.98	2.26	7.05	0.14	9.11	8.70	3.26	3.98	8.03
FERROSILITE	3.58	2.63	----	1.45	0.57	1.73	0.05	4.41	3.54	1.87	1.89	4.02
FORSTERITE	4.31	7.52	----	----	5.74	----	9.14	----	2.70	3.70	9.87	3.90
FAYALITE	2.71	3.11	----	----	1.60	----	3.50	----	1.21	2.33	5.17	2.15
MAGNETITE	1.72	2.97	3.92	2.63	3.73	4.96	5.71	6.73	4.64	5.91	3.27	2.93
ILMENITE	2.75	3.25	3.65	1.49	3.10	3.74	4.16	4.23	3.00	5.23	3.53	3.72
HEMATITE	----	----	3.37	----	----	----	----	----	----	----	----	----
APATITE	0.46	0.33	0.99	0.40	0.45	0.98	0.76	0.82	0.76	1.03	0.68	0.52
PYRITE	----	0.23	0.11	0.02	0.17	0.10	0.34	0.44	0.32	0.42	0.02	0.02
CALCITE	0.02	0.23	0.97	0.18	0.14	0.11	0.61	0.34	0.12	0.21	0.32	0.07
TRACE ELEMENTS (PPM)												
ARSENIC	3	4	7	4	4	4	5	7	5	6	8	4
BARIUM	215	87	520	590	359	651	365	470	352	400	185	221
COPPER	65	74	20	8	38	10	83	49	51	30	31	34
FLUORINE	740	410	570	720	490	650	650	500	470	500	400	310
MOLYBDENUM	1.7	1.7	2.1	2.3	1.6	1.3	1.2	2.4	2.1	2.4	5.6	2.7
LEAD	4	4	10	18	6	12	2	8	10	14	17	22
RUBIDIUM	20	20	170	186	109	49	114	41	71	45	44	55
SULPHUR	40	1140	540	160	820	500	1620	2120	1520	2060	180	180
TIN	1.5	1.1	2.4	2.4	0.8	2.6	1.7	2.6	2.0	3.6	2.3	2.0
STRONTIUM	283	252	293	171	380	362	369	320	434	346	358	355
ZINC	80	100	100	60	68	115	80	90	98	100	96	105
URANIUM	0.7	0.3	3.4	6.7	0.4	1.1	0.5	1.0	0.8	0.8	1.0	1.6

HUNTINGTON MOUNTAIN PLUTON DIORITIC COMPLEX

SAMPLE NO	F16C-1590	F16C-1597	F16C-1634	F16C-1637	F16C-1751	F16C-1760	F16C-1761	F16C-1785	F16C-1788
SIO2	53.34	56.60	58.88	51.19	53.55	48.67	47.01	66.27	48.83
TIO2	1.35	1.45	0.97	1.24	1.50	1.25	1.89	0.94	2.02
AL203	18.78	15.06	16.38	16.23	16.41	18.02	17.93	14.98	16.21
FE203	3.14	2.34	3.21	2.04	1.87	1.67	3.02	2.76	3.74
FEO	4.85	5.69	3.86	6.56	7.13	6.47	7.53	0.97	7.19
MNO	0.18	0.16	0.12	0.17	0.17	0.16	0.22	0.13	0.23
MGO	4.02	4.89	3.29	5.10	4.80	7.94	6.95	1.28	5.38
CAO	7.65	5.62	3.98	7.42	6.00	9.75	8.62	4.09	6.53
NA20	2.29	3.87	4.28	3.69	4.06	2.83	3.48	3.89	4.33
K20	1.15	2.38	2.85	1.09	1.37	0.61	0.81	3.04	0.37
H20+	3.16	1.70	2.38	3.39	2.87	2.23	2.04	1.23	3.35
H20-	0.14	0.13	0.13	0.12	0.13	0.23	0.21	0.02	0.15
P205	0.45	0.41	0.27	0.18	0.23	0.43	0.33	0.16	0.29
CO2	0.26	0.22	0.07	0.19	0.19	0.12	0.12	0.65	0.19
TOTAL OXIDES	100.76	100.52	100.67	98.61	100.28	100.38	100.16	100.41	98.81
NORMATIVE MINERALOGY									
QUARTZ	13.57	6.26	9.49	1.45	2.73	----	----	23.90	----
CORUNDUM	1.56	----	----	----	----	----	----	----	----
ORTHOCLASE	6.92	14.19	17.12	6.78	8.27	3.62	4.83	18.14	2.23
ALBITE	19.89	33.15	36.91	32.75	35.30	24.36	30.04	33.20	38.44
ANORTHITE	34.32	16.92	17.39	25.82	23.13	35.44	31.55	14.56	24.90
DIOPSIDE	----	4.08	0.37	5.35	2.29	6.08	5.24	0.55	3.28
HEDENBERGITE	----	1.78	0.12	3.16	1.54	2.27	2.19	----	1.51
ENSTATITE	10.28	10.41	8.18	10.85	11.22	9.92	0.92	2.96	11.46
FERROSILITE	4.50	5.22	3.05	7.34	8.66	4.24	0.44	----	6.03
FORSTERITE	----	----	----	----	----	5.20	10.01	----	0.74
FAYALITE	----	----	----	----	----	2.45	5.29	----	0.43
MAGNETITE	4.67	3.44	4.74	3.11	2.79	2.47	4.48	0.77	5.69
ILMENITE	2.63	2.79	1.86	2.48	2.93	2.42	3.66	1.80	4.01
HEMATITE	----	----	----	----	----	----	----	2.25	----
APATITE	1.05	0.96	0.62	0.42	0.55	1.00	0.78	0.37	0.68
PYRITE	----	0.31	----	0.04	0.15	0.25	0.32	----	0.15
CALCITE	0.61	0.48	0.14	0.46	0.44	0.28	0.26	1.49	0.45
TRACE ELEMENTS (PPM)									
ARSENIC	8	12	5	4	9	5	5	8	18
BARIUM	210	909	545	360	252	181	216	1000	100
COPPER	3	36	4	65	105	79	62	6	36
FLUORINE	760	820	620	620	620	440	430	740	540
MOLYBDENUM	4.7	3.2	1.9	1.4	1.8	2.2	2.5	1.0	1.8
LEAD:	25	11	6	8	17	14	14	22	10
RUBIDIUM	78	121	138	38	85	31	45	104	18
SULPHUR	60	1500	40	280	760	1220	1560	20	760
TIN	6.5	2.9	2.4	1.6	4.6	1.0	1.6	1.6	1.8
STRONTIUM	298	363	250	258	288	268	393	295	230
ZINC	123	105	78	110	100	84	138	87	115
URANIUM	1.5	2.6	3.2	0.9	0.9	0.6	0.3	2.2	0.9

HUNTINGTON MOUNTAIN PLUTON PORPHYRITIC QUARTZ MONZONITE

SAMPLE NO	F16C-1561	F16C-1566	F16C-1613
SIO2	70.64	70.55	72.79
TIO2	0.42	0.28	0.27
AL2O3	14.59	14.38	13.01
FE2O3	0.94	0.99	0.96
FEO	1.70	1.70	1.43
MNO	0.07	0.07	0.05
MGO	0.88	0.71	0.84
CAO	2.52	2.49	1.49
NA2O	4.38	4.21	3.82
K2O	2.96	3.09	3.65
H2O+	0.96	0.71	1.12
H2O-	0.00	0.00	0.00
P2O5	0.11	0.10	0.13
CO2	0.21	0.09	0.32
TOTAL OXIDES	100.38	99.37	99.88
NORMATIVE MINERALOGY			
QUARTZ	27.44	27.82	33.17
CORUNDUM	0.34	----	1.09
ORTHOCLASE	17.57	18.54	21.88
ALBITE	37.23	36.13	32.67
ANORTHITE	10.61	11.34	4.71
DIOPSIDE	----	0.01	----
HEDENBERGITE	----	0.01	----
ENSTATITE	2.18	1.79	2.10
FERROSILITE	1.79	1.99	1.48
FORSTERITE	----	----	----
FAYALITE	----	----	----
MAGNETITE	1.37	1.46	1.41
ILMENITE	0.78	0.52	0.50
HEMATITE	----	----	----
APATITE	0.23	0.21	0.28
PYRITE	----	----	----
CALCITE	0.46	0.19	0.72
TRACE ELEMENTS (PPM)			
ARSENIC	5	3	3
BARIUM	945	932	740
COPPER	20	1	2
FLUORINE	400	540	950
MOLYBDENUM	3.4	4.4	1.7
LEAD	16	12	6
RUBIDIUM	70	83	144
SULPHUR	60	80	40
TIN	3.5	1.6	2.1
STRONTIUM	178	211	102
ZINC	40	36	39
URANIUM	3.1	3.4	2.6

HUNTINGTON MOUNTAIN PLUTON BIOTITE GRANITE & LEUCOGRANITE

SAMPLE NO	F16C-1526	F16C-1529	F16C-1538	F16C-1539	F16C-1550	F16C-1558	F16C-1568	F16C-1578	F16C-1582	F16C-1598	F16C-1615	F16C-1618
SIO2	75.89	76.13	75.72	76.22	75.95	76.92	71.17	71.36	73.24	74.16	77.67	75.44
TIO2	0.18	0.25	0.18	0.30	0.18	0.23	0.27	0.38	0.22	0.23	0.17	0.13
AL203	11.81	11.37	11.51	11.74	11.93	11.57	13.63	13.86	12.58	13.21	11.76	12.22
FE203	0.52	0.16	0.44	0.07	0.38	0.64	0.67	1.54	0.38	0.78	0.32	0.50
FEO	0.67	0.80	1.04	1.39	0.90	1.07	1.77	1.70	1.21	0.83	0.95	0.87
MNO	0.02	0.03	0.03	0.03	0.04	0.03	0.05	0.06	0.02	0.02	0.03	0.03
MGO	0.26	0.22	0.52	0.34	0.34	0.43	0.77	0.76	0.38	0.41	0.33	0.22
CAO	0.80	0.83	1.23	1.21	0.99	1.34	2.07	2.22	1.46	1.22	1.06	1.08
NA2O	3.69	3.33	3.19	3.64	3.70	3.62	3.85	3.71	3.77	4.04	3.75	3.75
K2O	4.71	4.21	4.61	4.47	4.58	4.05	3.92	3.62	4.32	4.85	4.03	4.81
H2O+	0.68	0.75	0.84	0.54	0.64	0.60	1.19	1.05	0.88	0.95	0.70	0.73
H2O-	0.11	0.05	0.00	0.00	0.06	0.00	0.00	0.08	0.14	0.11	0.00	0.00
P2O5	0.03	0.04	0.05	0.05	0.04	0.05	0.11	0.11	0.07	0.05	0.04	0.06
CO2	0.04	0.02	0.35	0.07	0.06	0.04	0.11	0.07	0.07	0.08	0.19	0.16
TOTAL OXIDES	99.41	98.19	99.71	100.07	99.79	100.59	99.58	100.52	98.74	100.94	101.00	100.00
NORMATIVE MINERALOGY												
QUARTZ	35.16	39.37	37.12	35.02	34.78	37.19	28.39	30.15	31.92	29.47	37.72	33.33
CORUNDUM	----	----	----	----	----	----	----	0.21	----	----	----	----
ORTHOCLASE	28.27	25.59	27.60	26.52	27.36	23.97	23.58	21.55	26.10	28.68	23.77	28.68
ALBITE	31.59	28.86	27.24	30.96	31.62	30.64	33.04	31.51	32.58	34.16	31.64	31.98
ANORTHITE	1.81	3.78	3.52	2.53	2.43	3.32	8.48	10.00	4.79	3.63	3.31	2.31
DIOPSIDE	0.91	0.04	0.04	0.75	0.73	1.21	0.19	----	0.58	0.91	0.17	0.53
HEDENBERGITE	0.64	0.07	0.04	1.64	0.85	1.12	0.20	----	0.86	0.40	0.23	0.90
ENSTATITE	0.21	0.52	1.27	0.48	0.49	0.49	1.84	1.91	0.70	0.60	0.74	0.28
FERROSILITE	0.17	0.95	1.30	1.20	0.65	0.52	2.27	1.32	1.19	0.30	1.13	0.55
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.75	0.24	0.65	0.09	0.56	0.93	0.99	2.25	0.55	1.12	0.46	0.73
ILMENITE	0.33	0.49	0.33	0.57	0.33	0.44	0.50	0.73	0.41	0.44	0.30	0.23
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.05	0.07	0.12	0.12	0.07	0.12	0.26	0.23	0.17	0.12	0.09	0.14
PYRITE	0.04	----	----	----	----	----	----	----	----	0.02	----	----
CALCITE	0.07	0.02	0.78	0.14	0.14	0.07	0.25	0.14	0.16	0.16	0.43	0.34
TRACE ELEMENTS (PPM)												
ARSENIC	12	8	5	14	5	3	2	7	2	5	2	4
BARIUM	314	319	570	408	540	234	919	931	712	1350	316	490
COPPER	3	1	6	3	1	4	6	2	0	0	1	1
FLUORINE	200	270	830	1630	400	400	400	390	360	620	600	390
MOLYBDENUM	2.7	3.3	5.6	1.6	2.1	1.8	4.0	3.1	3.1	3.3	2.8	1.8
LEAD	4	16	14	16	16	10	8	14	25	14	18	12
RUBIDIUM	313	362	242	275	208	163	119	124	173	177	230	233
SULPHUR	220	40	80	40	40	20	40	20	40	120	20	40
TIN	3.7	3.1	0.8	3.0	1.7	3.3	3.0	1.9	2.9	2.4	3.7	2.5
STRONTIUM	43	66	75	85	55	53	116	172	78	99	73	36
ZINC	26	31	39	43	25	24	42	34	26	38	54	26
URANIUM	8.1	7.0	8.3	8.2	4.2	3.1	3.5	3.6	5.3	3.8	7.0	3.8

HUNTINGTON MOUNTAIN PLUTON BIOTITE GRANITE & LEUCOGRANITE

SAMPLE NO	F16C-1776
SIO2	75.39
TIO2	0.20
AL2O3	12.52
FE2O3	0.37
FEO	1.27
MNO	0.02
MGO	0.44
CAO	1.38
NA2O	3.79
K2O	4.44
H2O+	0.82
H2O-	0.21
P2O5	0.07
CO2	0.09
TOTAL OXIDES	101.01
NORMATIVE MINERALOGY	
QUARTZ	32.89
CORUNDUM	----
ORTHOCLASE	26.20
ALBITE	32.06
ANORTHITE	4.03
DIOPSIDE	0.73
HEDENBERGITE	0.88
ENSTATITE	0.73
FERROSILITE	1.02
FORSTERITE	----
FAYALITE	----
MAGNETITE	0.54
ILMENITE	0.38
HEMATITE	----
APATITE	0.14
PYRITE	0.23
CALCITE	0.18
TRACE ELEMENTS (PPM)	
ARSENIC	5
BARIUM	560
COPPER	0
FLUORINE	350
MOLYBDENUM	2.8
LEAD	14
RUBIDIUM	152
SULPHUR	1160
TIN	1.7
STRONTIUM	63
ZINC	31
URANIUM	3.5

HUNTINGTON MOUNTAIN PLUTON GRAPHIC GRANITE

SAMPLE NO	F16C-1605	F16C-1631	F16C-1635	F16C-1782
SIO2	72.07	70.36	72.22	75.56
TIO2	0.43	0.23	0.33	0.22
AL2O3	14.03	15.70	13.83	13.20
FE2O3	0.87	0.52	1.03	0.17
FEO	1.09	1.78	1.18	1.13
MNO	0.09	0.05	0.04	0.03
MGO	0.53	0.63	0.68	0.29
CAO	1.06	1.47	1.67	0.87
NA2O	5.31	4.59	4.00	4.18
K2O	3.03	4.17	4.09	4.52
H2O+	1.07	1.01	0.65	0.71
H2O-	0.15	0.12	0.08	0.19
P2O5	0.10	0.12	0.10	0.07
CO2	0.11	0.06	0.03	0.05
TOTAL OXIDES	99.94	100.81	99.93	101.19
NORMATIVE MINERALOGY				
QUARTZ	27.25	23.06	28.92	31.17
CORUNDUM	0.55	1.36	0.06	0.10
ORTHOCLASE	18.12	24.70	24.40	26.65
ALBITE	45.42	38.99	34.14	35.26
ANORTHITE	4.02	6.23	7.57	3.60
DIOPSIDE	----	----	----	----
HEDENBERGITE	----	----	----	----
ENSTATITE	1.33	1.55	1.68	0.70
FERROSILITE	0.27	2.54	0.82	1.50
FORSTERITE	----	----	----	----
FAYALITE	----	----	----	----
MAGNETITE	1.28	0.76	1.51	0.25
ILMENITE	0.81	0.44	0.63	0.40
HEMATITE	----	----	----	----
APATITE	0.24	0.26	0.21	0.14
PYRITE	0.50	----	----	0.14
CALCITE	0.23	0.11	0.07	0.11
TRACE ELEMENTS (PPM)				
ARSENIC	13	3	7	8
BARIUM	955	780	800	545
COPPER	2	4	3	1
FLUORINE	580	490	1030	350
MOLYBDENUM	2.0	4.6	2.4	3.7
LEAD	22	14	12	22
RUBIDIUM	104	180	170	190
SULPHUR	2460	60	40	760
TIN	1.7	2.0	0.6	1.8
STRONTIUM	77	118	158	77
ZINC	60	44	28	39
URANIUM	2.7	4.7	4.4	5.7

KELLYS MOUNTAIN PLUTON DIORITIC COMPLEX

SAMPLE NO	K2-1013	K7-1031	K7-1040	K2-1093	K2-1095	K2-1109	K8-1116	K7-1125	K7-1130	K7-1137	K7-1212	K7-1220
SIO2	59.51	63.90	59.39	47.95	53.22	54.53	53.96	50.42	51.68	51.02	52.22	57.77
TIO2	0.75	0.57	1.37	2.10	2.10	1.07	1.64	0.95	1.44	1.97	1.04	0.77
AL2O3	18.38	16.63	18.18	17.15	18.09	18.28	17.72	18.55	18.65	16.16	18.34	17.31
FE2O3	2.02	1.22	1.35	4.47	4.29	1.46	3.66	2.04	2.39	2.81	0.87	1.40
FEO	3.45	1.80	4.44	7.02	5.31	4.79	5.13	4.08	5.47	7.58	4.13	4.35
MNO	0.16	0.07	0.12	0.15	0.16	0.12	0.13	0.12	0.14	0.20	0.13	0.11
MGO	1.51	1.23	3.31	5.35	3.69	5.33	4.13	7.84	5.10	5.13	5.97	3.30
CAO	3.61	3.79	5.52	8.55	6.48	6.78	4.67	11.48	8.53	8.16	9.40	5.17
NA2O	5.75	4.91	1.90	3.26	4.21	4.09	4.29	2.52	3.39	3.64	3.14	4.19
K2O	1.97	2.10	2.10	0.78	1.21	1.40	1.85	0.72	1.08	1.18	1.24	1.80
H2O+	0.99	1.16	1.80	1.73	1.70	2.09	2.09	1.71	1.23	2.58	1.86	1.60
H2O-	0.12	0.16	0.10	0.08	0.07	0.15	0.19	0.30	0.00	0.07	0.16	0.05
P2O5	0.17	0.16	0.07	0.23	0.38	0.20	0.31	0.13	0.19	0.24	0.14	0.18
CO2	0.09	0.35	0.12	0.05	0.04	0.14	0.52	0.12	0.16	0.18	0.14	0.18
TOTAL OXIDES	98.48	98.05	99.77	98.87	100.95	100.43	100.29	100.98	99.45	100.92	98.78	98.18
NORMATIVE MINERALOGY												
QUARTZ	7.82	18.80	22.39	0.21	5.10	2.05	6.60	----	2.03	0.45	1.32	9.39
CORUNDUM	0.84	0.60	3.25	----	----	----	2.17	----	----	----	----	----
ORTHOCLASE	11.91	12.79	12.63	4.75	7.22	8.38	11.16	4.25	6.44	7.04	7.58	10.98
ALBITE	49.98	42.88	16.34	28.40	35.94	35.26	36.92	21.47	29.20	31.32	27.45	36.66
ANORTHITE	16.75	16.14	26.81	30.71	27.13	27.90	18.22	37.63	33.07	24.69	33.37	24.00
DIOPSIDE	----	----	----	6.53	1.63	2.43	----	12.15	4.47	7.17	8.02	0.14
HEDENBERGITE	----	----	----	2.46	0.47	0.96	----	2.42	1.77	4.15	2.45	0.08
ENSTATITE	3.84	3.14	8.42	10.66	8.49	12.40	10.46	12.36	10.83	9.64	11.62	8.43
FERROSILITE	3.74	1.50	4.96	4.60	2.81	5.61	3.70	2.82	4.91	6.40	4.08	5.80
FORSTERITE	----	----	----	----	----	----	----	1.22	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	0.31	----	----	----	----
MAGNETITE	3.01	1.83	2.00	6.67	6.28	2.16	5.41	2.99	3.53	4.14	1.30	2.10
ILMENITE	1.46	1.12	2.64	4.09	4.01	2.07	3.18	1.81	2.77	3.79	2.02	1.50
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.38	0.36	0.14	0.53	0.87	0.45	0.73	0.31	0.45	0.54	0.31	0.41
PYRITE	0.09	0.02	0.13	0.28	----	0.02	0.27	----	0.19	0.27	0.17	0.11
CALCITE	0.19	0.82	0.28	0.12	0.07	0.32	1.18	0.28	0.35	0.39	0.31	0.40
TRACE ELEMENTS (PPM)												
ARSENIC	4	7	8	3	13	8	4	5	8	8	5	11
BARIUM	545	570	420	326	327	430	341	136	210	280	227	480
COPPER	12	4	27	122	16	35	18	53	60	87	62	27
FLUORINE	790	670	350	350	540	380	580	260	280	440	600	630
MOLYBDENUM	1.2	2.5	1.7	1.9	2.1	1.3	2.3	2.6	2.4	2.9	2.5	2.0
LEAD	10	4	8	2	8	6	6	33	12	10	2	16
RUBIDIUM	115	60	81	22	42	48	64	22	45	45	35	58
SULPHUR	420	110	680	1360	80	180	1340	20	980	1360	820	500
TIN	3.4	2.1	2.8	1.3	1.7	1.3	1.7	2.6	6.3	7.8	1.8	1.4
STRONTIUM	301	272	370	533	525	308	479	399	415	310	411	402
ZINC	82	45	80	103	110	74	95	58	83	100	57	60
URANIUM	2.8	1.3	1.3	0.5	0.6	0.6	1.3	2.0	0.7	1.7	0.6	0.6

KELLYS MOUNTAIN PLUTON DIORITIC COMPLEX

SAMPLE NO	K2-1231
SIO2	51.46
TIO2	0.70
AL203	18.29
FE203	1.57
FEO	5.63
MNO	0.14
MGO	5.35
CAO	9.90
NA20	3.26
K20	0.86
H20+	1.86
H20-	0.23
P205	0.20
C02	0.14
TOTAL OXIDES	99.59
NORMATIVE MINERALOGY	
QUARTZ	0.40
CORUNDUM	----
ORTHOCLASE	5.16
ALBITE	28.31
ANORTHITE	33.60
DIOPSIDE	7.75
HEDENBERGITE	4.12
ENSTATITE	10.05
FERROSILITE	6.12
FORSTERITE	----
FAYALITE	----
MAGNETITE	2.35
ILMENITE	1.35
HEMATITE	----
APATITE	0.48
PYRITE	0.02
CALCITE	0.30
TRACE ELEMENTS (PPM)	
ARSENIC	8
BARIUM	550
COPPER	15
FLUORINE	420
MOLYBDENUM	2.4
LEAD	2
RUBIDIUM	25
SULPHUR	180
TIN	1.8
STRONTIUM	310
ZINC	73
URANIUM	0.2

KELLYS MOUNTAIN PLUTON BIOTITE GRANODIORITE

SAMPLE NO	K2-1090	K7-1204	K7-1206	K7-1207	K7-1208
SIO2	67.26	68.32	69.97	66.90	67.45
TIO2	1.80	0.53	0.34	0.17	0.47
AL203	16.48	15.95	15.02	16.71	15.81
FE203	1.57	0.53	0.41	1.47	0.39
FEO	2.36	1.78	1.58	1.07	2.07
MNO	0.11	0.06	0.09	0.02	0.07
MGO	0.44	1.00	0.85	1.01	1.01
CAO	2.39	2.87	2.05	3.12	3.06
NA20	5.22	5.06	5.04	5.15	5.11
K20	2.24	2.67	2.39	2.12	2.14
H20+	0.84	0.98	1.10	0.71	1.07
H20-	0.03	0.06	0.13	0.06	0.11
P205	0.14	0.13	0.14	0.08	0.14
C02	0.07	0.07	0.33	0.02	0.11
TOTAL OXIDES	100.95	100.01	99.44	98.61	99.01
NORMATIVE MINERALOGY					
QUARTZ	23.12	20.85	26.71	21.11	21.30
CORUNDUM	1.65	----	1.54	0.47	0.07
ORTHOCLASE	13.19	15.96	14.41	12.82	12.95
ALBITE	44.07	43.27	43.36	44.55	44.22
ANORTHITE	10.50	13.03	7.32	15.29	14.01
DIOPSIDE	----	0.06	----	----	----
HEDENBERGITE	----	0.04	----	----	----
ENSTATITE	1.07	2.49	2.16	2.55	2.55
FERROSILITE	0.25	2.07	2.17	0.51	2.88
FORSTERITE	----	----	----	----	----
FAYALITE	----	----	----	----	----
MAGNETITE	2.28	0.78	0.61	2.18	0.58
ILMENITE	3.40	1.02	0.64	0.31	0.91
HEMATITE	----	----	----	----	----
APATITE	0.33	0.31	0.31	0.17	0.31
PYRITE	----	----	0.02	0.02	----
CALCITE	0.16	0.14	0.77	0.02	0.23
TRACE ELEMENTS (PPM)					
ARSENIC	8	14	5	5	4
BARIUM	58	400	490	590	408
COPPER	1	2	6	4	3
FLUORINE	470	620	370	560	600
MOLYBDENUM	2.4	2.5	1.8	2.9	1.9
LEAD	8	2	6	12	8
RUBIDIUM	66	77	90	99	72
SULPHUR	60	70	170	120	80
TIN	1.8	3.0	3.0	1.7	2.9
STRONTIUM	680	270	163	121	269
ZINC	70	54	47	25	51
URANIUM	1.6	1.0	1.0	1.5	1.4

KELLYS MOUNTAIN PLUTON LEUCOGRANITE

SAMPLE NO	K7-1027	K7-1056	K8-1063	K1-1067	K8-1072	K8-1084	K8-1085	K2-1108	K2-1110	K8-1111	K8-1117	K8-1120
SIO2	68.89	72.92	77.89	76.76	73.10	73.77	74.22	72.95	71.26	74.93	73.24	75.20
TIO2	1.32	0.11	0.13	0.09	0.20	0.28	0.18	0.33	0.40	0.13	0.30	0.17
AL203	14.71	12.95	11.96	12.32	12.95	13.41	12.90	14.12	14.67	11.71	12.59	12.55
FE203	0.45	0.36	0.23	0.45	0.41	1.06	0.49	0.80	0.54	0.62	0.96	0.27
FEO	1.69	0.73	0.69	0.43	1.10	1.05	1.06	1.13	1.63	0.71	0.50	1.10
MNO	0.04	0.03	0.01	0.02	0.02	0.04	0.03	0.04	0.05	0.01	0.02	0.02
MGO	0.79	0.10	0.20	0.14	2.24	0.76	0.47	0.45	0.79	0.26	0.37	0.35
CAO	2.35	2.64	0.51	0.80	1.47	1.47	1.44	1.47	2.13	1.18	1.27	1.30
NA20	4.61	3.88	3.29	4.06	4.14	4.10	4.07	5.23	4.35	3.60	3.79	3.50
K20	2.91	4.62	4.58	4.57	3.91	3.49	3.62	2.95	2.45	4.59	4.09	4.16
H20+	1.02	0.67	0.58	0.61	0.81	1.07	0.77	0.72	1.07	0.55	0.88	0.68
H20-	0.14	0.50	0.09	0.04	0.14	0.14	0.13	0.06	0.05	0.15	0.15	0.11
P205	0.13	0.04	0.03	0.07	0.09	0.06	0.05	0.08	0.12	0.03	0.08	0.06
CO2	0.28	0.08	0.05	0.07	0.05	0.25	0.09	0.09	0.02	0.11	0.41	0.11
TOTAL OXIDES	99.37	99.63	100.24	100.43	100.63	100.95	99.52	100.42	99.53	98.58	98.65	99.58
NORMATIVE MINERALOGY												
QUARTZ	26.15	28.98	39.80	34.38	27.76	33.01	33.20	27.64	30.87	35.01	34.38	35.87
CORUNDUM	0.70	----	0.84	----	----	0.96	----	0.06	1.33	----	0.72	0.33
ORTHOCLASE	17.48	27.77	27.22	27.05	23.16	20.65	21.73	17.52	14.73	27.76	24.80	24.86
ALBITE	39.76	33.28	27.97	34.45	35.08	34.72	34.86	44.35	37.33	31.05	32.87	29.99
ANORTHITE	9.16	4.35	2.03	1.89	5.26	5.35	6.34	6.24	9.90	2.29	3.40	5.44
DIOPSIDE	----	0.55	----	0.55	0.76	----	0.03	----	----	1.24	----	----
HEDENBERGITE	----	1.80	----	0.43	0.17	----	0.03	----	----	1.07	----	----
ENSTATITE	1.98	----	0.50	0.07	5.22	1.90	1.17	1.10	1.98	0.06	0.92	0.86
FERROSILITE	0.58	----	0.90	0.06	1.31	0.67	1.30	0.91	2.01	0.06	----	1.54
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.67	0.52	0.34	0.65	0.58	1.54	0.72	1.17	0.80	0.92	0.83	0.38
ILMENITE	2.56	0.19	0.23	0.15	0.38	0.51	0.33	0.63	0.77	0.23	0.58	0.31
HEMATITE	----	----	----	----	----	----	----	----	----	----	0.41	----
APATITE	0.31	0.07	0.07	0.16	0.19	0.14	0.09	0.19	0.26	0.07	0.17	0.14
PYRITE	0.02	----	----	----	----	----	----	0.02	----	----	----	0.04
CALCITE	0.65	0.16	0.11	0.16	0.11	0.55	0.19	0.18	0.02	0.23	0.93	0.23
TRACE ELEMENTS (PPM)												
ARSENIC	8	3	8	4	7	7	5	5	4	5	5	4
BARIUM	100	100	749	751	378	456	431	589	591	391	765	645
COPPER	2	2	1	0	3	2	2	2	2	4	4	4
FLUORINE	460	230	180	470	210	290	310	400	330	200	250	320
MOLYBDENUM	3.0	3.0	1.4	1.2	1.6	2.8	4.4	0.9	2.3	2.5	2.2	2.8
LEAD	8	9	14	16	10	12	14	8	8	28	8	14
RUBIDIUM	100	251	113	146	119	132	151	80	75	179	153	116
SULPHUR	100	20	80	60	20	40	20	160	40	40	80	240
TIN	4.2	3.3	2.5	1.5	2.4	3.1	1.6	1.5	1.4	2.1	1.5	2.0
STRONTIUM	411	46	37	34	103	153	107	155	180	68	100	83
ZINC	38	18	18	14	17	30	21	26	29	13	25	15
URANIUM	1.8	2.2	1.3	1.4	2.7	1.9	2.7	1.3	1.5	2.0	2.8	2.7

KELLYS MOUNTAIN PLUTON LEUCOGRANITE

SAMPLE NO	K7-1134	K7-1140	K8-1148	K8-1150	K8-1152	K8-1153	K8-1156	K8-1160	K8-1167	K8-1178	K8-1185	K7-1194
SIO2	75.78	73.77	70.52	73.03	77.64	76.07	72.25	73.27	75.42	76.62	71.33	76.53
TIO2	0.15	0.32	0.35	0.23	0.14	0.23	0.33	0.29	0.17	0.15	0.18	0.12
AL2O3	12.82	12.97	13.18	13.24	11.25	12.88	13.75	13.35	13.00	12.16	14.10	12.07
FE2O3	0.13	1.66	0.60	0.57	0.21	0.16	0.50	0.67	0.26	0.64	0.69	0.20
FEO	1.11	0.67	1.68	1.29	0.71	0.95	1.55	1.11	1.11	0.92	0.91	0.54
MNO	0.02	0.03	0.06	0.04	0.02	0.02	0.04	0.03	0.03	0.03	0.03	0.02
MGO	0.33	0.60	0.68	0.50	0.18	0.31	0.73	0.63	0.46	0.43	0.58	0.08
CAO	1.25	2.69	2.01	1.74	1.04	0.80	1.20	1.51	1.41	1.02	1.89	0.67
NA2O	3.59	4.26	4.28	4.41	3.62	4.18	4.59	4.30	3.86	3.58	4.83	3.71
K2O	4.36	1.77	3.13	3.20	4.59	4.20	3.02	3.45	3.96	4.22	2.73	4.91
H2O+	0.73	0.78	1.36	0.71	0.80	0.75	1.01	0.98	0.67	0.97	1.29	0.59
H2O-	0.11	0.00	0.13	0.12	0.16	0.09	0.12	0.25	0.06	0.07	0.08	0.13
P2O5	0.05	0.06	0.09	0.08	0.07	0.07	0.11	0.11	0.06	0.07	0.13	0.05
CO2	0.12	0.09	1.15	0.09	0.12	0.07	0.04	0.05	0.42	0.21	1.20	0.55
TOTAL OXIDES	100.55	99.67	99.22	99.25	100.55	100.78	99.24	100.00	100.89	101.09	99.97	100.17
NORMATIVE MINERALOGY												
QUARTZ	34.80	36.72	31.52	31.09	37.45	33.38	30.44	31.23	34.75	37.21	31.54	36.19
CORUNDUM	0.28	----	2.03	----	----	0.33	1.09	0.17	0.94	0.48	2.87	0.67
ORTHOCLASE	25.88	10.59	18.89	19.24	27.28	24.81	18.16	20.68	23.35	24.91	16.39	29.16
ALBITE	30.48	36.38	37.07	37.84	30.77	35.40	39.61	36.86	32.55	30.21	41.47	31.50
ANORTHITE	5.20	11.22	2.16	7.03	0.88	3.07	5.21	6.56	3.96	3.40	1.02	----
DIOPSIDE	----	1.04	----	0.28	0.88	----	----	----	----	----	----	----
HEDENBERGITE	----	----	----	0.30	1.69	----	----	----	----	----	----	----
ENSTATITE	0.83	1.03	1.71	1.14	0.02	0.77	1.85	1.56	1.15	1.05	1.44	0.13
FERROSILITE	1.72	----	2.17	1.43	0.04	1.25	1.97	1.08	1.59	0.92	0.90	0.43
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.18	1.31	0.89	0.83	0.31	0.23	0.73	0.97	0.36	0.91	1.00	0.29
ILMENITE	0.29	0.62	0.66	0.44	0.25	0.44	0.64	0.54	0.30	0.29	0.33	0.23
HEMATITE	----	0.76	----	----	----	----	----	----	----	----	----	----
APATITE	0.09	0.14	0.21	0.19	0.16	0.16	0.24	0.24	0.14	0.14	0.28	0.12
PYRITE	----	----	----	----	----	----	----	----	----	0.04	----	0.04
CALCITE	0.27	0.18	2.68	0.19	0.27	0.16	0.07	0.12	0.93	0.46	2.77	1.26
TRACE ELEMENTS (PPM)												
ARSENIC	7	5	7	3	4	9	8	7	4	7	8	12
BARIUM	875	371	423	658	342	570	645	539	292	404	420	190
COPPER	2	3	6	1	3	1	1	1	2	1	1	0
FLUORINE	300	330	690	400	400	300	400	400	560	600	540	730
MOLYBDENUM	3.1	2.8	1.2	1.3	1.2	1.2	1.3	1.3	1.6	1.9	1.3	1.8
LEAD	12	14	8	9	9	14	12	8	8	8	2	10
RUBIDIUM	160	67	97	119	189	116	105	117	166	145	174	178
SULPHUR	60	60	40	60	20	60	20	60	60	260	80	220
TIN	9.5	5.5	1.6	1.9	1.6	1.4	1.9	1.8	2.5	2.7	2.1	2.6
STRONTIUM	97	214	167	135	55	50	157	134	134	108	108	33
ZINC	16	33	41	37	15	30	32	28	18	20	22	12
URANIUM	1.6	2.5	1.9	1.2	2.7	2.2	1.1	1.8	2.5	2.2	2.6	2.5

KELLYS MOUNTAIN PLUTON FINE-GRAINED LEUCOGRANITE

SAMPLE NO	K2-1009	K8-1076	K7-1128	K7-1141	K8-1149	K8-1171	K8-1173	K8-1223
SIO2	75.11	76.99	71.10	74.68	77.25	75.58	74.38	75.58
TIO2	0.08	0.14	0.25	0.22	0.11	0.15	0.13	0.06
AL203	11.69	11.11	15.34	11.79	11.62	11.53	13.35	11.67
FE203	0.38	0.14	1.04	0.04	0.14	0.09	0.25	0.19
FEO	0.69	0.81	1.49	1.34	0.87	0.79	0.71	0.60
MNO	0.01	0.01	0.05	0.01	0.04	0.01	0.01	0.02
MGO	0.08	0.22	0.54	0.17	0.08	0.12	0.22	0.05
CAO	0.92	1.03	1.75	0.98	0.87	1.02	1.35	0.95
NA2O	3.53	2.54	4.87	3.17	3.52	3.76	3.55	4.22
K2O	4.64	4.99	3.28	5.87	4.50	4.89	3.99	4.40
H2O+	0.62	0.83	0.98	0.66	0.99	0.70	0.54	0.62
H2O-	0.10	0.15	0.14	0.09	0.15	0.06	0.09	0.07
P2O5	0.03	0.04	0.06	0.08	0.03	0.03	0.05	0.05
CO2	0.18	0.02	0.07	0.04	0.12	0.46	0.14	0.35
TOTAL OXIDES	98.06	99.02	100.96	99.14	100.29	99.19	98.76	98.83
NORMATIVE MINERALOGY								
QUARTZ	36.09	41.13	25.37	32.06	37.89	34.39	36.08	33.94
CORUNDUM	----	----	0.89	----	----	----	1.18	----
ORTHOCLASE	28.15	30.12	19.44	35.30	26.85	29.34	24.01	26.54
ALBITE	30.70	21.93	41.29	27.27	29.96	32.34	30.54	36.20
ANORTHITE	2.40	4.25	7.86	0.60	2.67	0.13	5.72	----
DIOPSIDE	0.19	0.20	----	0.59	0.09	0.40	----	0.27
HEDENBERGITE	0.71	0.39	----	2.62	0.54	1.31	----	1.71
ENSTATITE	0.12	0.44	1.32	0.13	0.16	0.12	0.53	----
FERROSILITE	0.48	0.97	1.54	0.68	1.08	0.45	0.94	----
FORSTERITE	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----
MAGNETITE	0.57	0.21	1.51	0.06	0.21	0.13	0.37	0.23
ILMENITE	0.14	0.25	0.48	0.41	0.19	0.29	0.23	0.12
HEMATITE	----	----	----	----	----	----	----	----
APATITE	0.05	0.07	0.14	0.17	0.07	0.05	0.10	0.10
PYRITE	----	----	----	0.06	0.02	----	----	----
CALCITE	0.40	0.02	0.16	0.07	0.28	1.04	0.30	0.79
TRACE ELEMENTS (PPM)								
ARSENIC	2	7	14	7	5	5	3	5
BARIUM	31	288	459	392	72	150	250	20
COPPER	1	4	6	8	14	4	1	6
FLUORINE	790	190	290	250	430	400	620	500
MOLYBDENUM	2.5	3.1	1.8	2.9	5.9	2.4	1.8	2.3
LEAD	16	17	4	32	19	12	10	8
RUBIDIUM	113	122	88	152	254	222	204	285
SULPHUR	20	60	60	360	140	70	70	80
TIN	2.1	3.2	6.0	3.9	6.7	2.6	1.9	3.3
STRONTIUM	28	33	121	92	23	51	58	11
ZINC	5	18	27	11	48	9	9	16
URANIUM	1.1	3.1	2.4	2.2	3.5	3.1	3.7	2.4

KELLYS MOUNTAIN PLUTON LEUCOGRANITE

SAMPLE NO	K8-1198	K7-1210	K8-1224	K8-1227
SIO2	71.33	74.44	75.36	74.18
TIO2	0.20	0.27	0.11	0.14
AL2O3	14.10	12.15	11.09	12.21
FE2O3	0.48	0.15	0.11	0.13
FEO	1.10	1.19	0.80	1.13
MNO	0.04	0.02	0.01	0.02
MGO	0.58	0.44	0.06	0.29
CAO	1.89	1.42	0.85	1.06
NA2O	4.83	4.20	3.65	3.94
K2O	2.73	3.58	4.92	4.68
H2O+	1.10	0.80	0.72	0.81
H2O-	0.19	0.07	0.06	0.08
P2O5	0.10	0.05	0.04	0.07
CO2	0.53	0.21	0.16	0.51
TOTAL OXIDES	99.20	98.99	97.94	99.25
NORMATIVE MINERALOGY				
QUARTZ	29.57	33.68	35.60	31.97
CORUNDUM	1.21	----	----	0.04
ORTHOCLASE	16.50	21.53	29.91	28.16
ALBITE	41.76	36.15	30.51	33.83
ANORTHITE	5.62	3.84	----	1.74
DIOPSIDE	----	0.60	0.32	----
HEDENBERGITE	----	0.80	2.45	----
ENSTATITE	1.45	0.82	----	0.71
FERROSILITE	1.37	1.25	0.04	1.80
FORSTERITE	----	----	----	----
FAYALITE	----	----	----	----
MAGNETITE	0.70	0.21	----	0.19
ILMENITE	0.39	0.30	0.20	0.25
HEMATITE	----	----	----	----
APATITE	0.21	0.12	0.07	0.14
PYRITE	0.02	0.02	----	0.02
CALCITE	1.21	0.49	0.35	1.16
TRACE ELEMENTS (PPM)				
ARSENIC	4	12	4	3
BARIUM	680	1300	207	685
COPPER	1	1	1	3
FLUORINE	520	600	440	1520
MOLYBDENUM	1.8	1.8	1.4	3.2
LEAD	4	12	8	8
RUBIDIUM	85	124	238	155
SULPHUR	140	140	20	120
TIN	1.3	2.4	2.0	2.9
STRONTIUM	262	98	28	70
ZINC	36	22	15	19
URANIUM	1.0	1.3	2.0	2.2

ST ANNS MOUNTAIN PLUTON HORNBLENDE GRANODIORITE

SAMPLE NO	K7A-1517	K7A-1534	K7A-1561	K7A-1566	K7A-1574	K7A-1621	K7A-1631	K7A-1642	K7A-1645	K7A-1765	K7A-1811
SIO2	65.32	60.92	54.71	56.35	52.95	58.45	62.19	49.12	63.41	55.92	55.44
TIO2	0.62	0.67	0.90	0.87	1.20	0.47	0.64	0.88	0.54	0.80	0.79
AL203	14.52	16.26	17.35	18.63	17.00	19.10	14.86	16.36	15.47	17.19	17.39
FE203	2.28	2.53	3.64	3.33	4.02	1.70	2.70	4.18	2.86	2.21	4.71
FEO	2.65	3.40	4.26	4.26	4.64	2.03	2.80	5.26	1.93	4.39	2.60
MNO	0.11	0.12	0.15	0.17	0.18	0.14	0.07	0.15	0.08	0.17	0.12
MGO	1.97	2.90	3.62	3.48	3.97	1.57	1.85	4.95	1.52	3.96	2.73
CAO	3.82	5.10	6.07	5.68	7.61	7.05	4.52	6.83	3.26	6.86	5.56
NA20	3.27	3.37	3.42	3.21	3.09	6.77	2.62	2.61	3.05	2.21	3.19
K20	3.63	2.91	2.46	2.33	1.81	2.20	2.93	2.67	4.14	2.16	2.80
H20+	1.30	1.63	2.37	1.53	1.60	0.71	2.25	3.29	1.59	1.91	1.78
H20-	0.08	0.27	0.41	0.28	0.26	0.20	0.31	0.16	0.18	0.16	0.25
P205	0.15	0.15	0.23	0.23	0.29	0.15	0.14	0.11	0.13	0.26	0.25
CO2	0.05	0.24	0.41	0.03	1.04	0.14	0.87	2.94	1.49	0.17	0.75
TOTAL OXIDES	99.77	100.47	100.00	100.38	99.66	100.68	98.75	99.51	99.65	98.37	98.36
NORMATIVE MINERALOGY											
QUARTZ	22.08	15.25	7.65	10.56	8.52	----	26.12	8.09	25.45	13.77	13.53
CORUNDUM	----	----	----	1.13	----	----	1.52	3.96	3.92	----	1.41
ORTHOCLASE	21.78	17.41	14.92	13.93	10.95	13.05	18.03	16.45	24.97	13.21	17.14
ALBITE	28.05	28.94	29.78	27.48	26.74	50.94	23.06	22.92	26.29	19.34	27.95
ANORTHITE	14.50	20.95	25.47	26.95	27.79	15.27	16.78	15.32	6.03	31.86	22.03
DIOPSIDE	1.99	1.28	0.79	----	1.36	8.45	----	----	----	0.37	----
HEDENBERGITE	0.76	0.50	0.27	----	0.43	3.37	----	----	----	0.17	----
ENSTATITE	4.04	6.74	8.91	8.80	9.46	----	4.79	12.82	3.87	10.05	7.06
FERROSILITE	1.77	3.03	3.55	3.97	3.39	----	2.03	5.21	0.44	5.28	----
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	3.35	3.72	5.43	4.90	5.96	2.47	4.07	6.33	4.22	3.33	6.70
ILMENITE	1.20	1.29	1.74	1.68	2.33	0.90	1.26	1.72	1.03	1.58	1.54
HEMATITE	----	----	----	----	----	----	----	----	----	----	0.28
APATITE	0.35	0.33	0.53	0.52	0.66	0.35	0.31	0.24	0.31	0.60	0.60
PYRITE	0.02	----	----	0.02	----	----	----	----	----	0.04	----
CALCITE	0.12	0.55	0.96	0.07	2.42	0.30	2.03	6.94	3.46	0.40	1.77
TRACE ELEMENTS (PPM)											
ARSENIC	3	8	11	14	5	7	11	12	14	8	8
BARIUM	547	425	480	485	340	388	110	460	600	390	477
COPPER	88	62	74	128	108	20	27	143	14	73	105
FLUORINE	540	930	640	670	560	560	490	460	600	490	500
MOLYBDENUM	1.5	2.2	2.5	1.6	2.1	1.3	1.9	2.8	2.1	1.2	1.6
LEAD	2	10	3	3	23	16	14	12	14	14	14
RUBIDIUM	125	90	62	62	58	48	96	90	113	63	65
SULPHUR	120	20	10	190	60	80	40	30	20	220	80
TIN	2.4	2.4	1.7	1.1	1.3	2.6	2.2	2.0	2.7	1.8	2.0
STRONTIUM	374	395	473	464	583	558	118	328	270	570	630
ZINC	48	63	82	86	103	53	57	119	65	100	61
URANIUM	2.2	1.4	1.0	0.8	0.7	2.9	2.2	1.1	2.0	0.9	1.6

ST ANNS MTN PLUTON HORNBLENDE BIOTITE GRANITE,GRANODIORITE

SAMPLE NO	K7A-1514	K7A-1550	K7A-1584	K7A-1589	K7A-1605	K7A-1618	K7A-1619	K7A-1620	K7A-1756	K7A-1773	K7A-1804
SIO2	70.11	65.15	66.17	68.17	63.92	67.53	69.72	67.67	67.15	67.22	67.23
TIO2	0.32	0.48	0.28	0.25	0.27	0.30	0.23	0.28	0.41	0.18	0.32
AL203	15.33	15.96	16.55	14.92	17.40	14.83	14.90	15.18	14.29	15.29	15.37
FE203	1.26	1.76	1.28	0.43	0.68	1.79	1.11	1.02	1.75	1.18	2.15
FEO	1.75	2.46	2.18	2.33	2.18	2.10	1.57	1.90	2.07	1.82	1.47
MNO	0.10	0.08	0.09	0.04	0.06	0.10	0.06	0.10	0.09	0.06	0.09
MGO	1.22	1.09	1.93	1.62	1.65	1.45	0.99	1.12	1.60	1.49	1.37
CAO	2.49	3.72	3.95	1.24	3.69	3.64	1.13	2.28	3.14	3.16	2.99
NA20	3.82	3.46	3.84	4.63	4.21	3.40	4.03	3.92	3.35	4.05	3.44
K20	3.18	3.34	1.80	2.40	1.84	2.87	3.51	3.16	3.38	2.43	3.43
H20+	1.04	1.30	1.72	2.06	1.96	1.18	1.16	1.13	1.30	1.71	1.25
H20-	0.11	0.28	0.26	0.26	0.11	0.21	0.23	0.19	0.12	0.17	0.33
P205	0.14	0.14	0.12	0.11	0.11	0.13	0.12	0.12	0.12	0.07	0.12
CO2	0.02	0.12	0.09	0.60	0.14	0.36	0.16	0.16	0.27	0.41	0.36
TOTAL OXIDES	100.89	99.34	100.26	99.06	98.22	99.89	98.92	98.23	99.04	99.24	99.92
NORMATIVE MINERALOGY											
QUARTZ	28.34	22.84	25.43	28.33	22.15	27.65	29.64	26.76	26.61	26.35	27.21
CORUNDUM	1.46	0.51	1.58	4.26	2.42	0.66	3.09	1.84	0.36	1.38	1.70
ORTHOCLASE	18.87	20.22	10.78	14.68	11.33	17.24	21.30	19.24	20.42	14.77	20.65
ALBITE	32.34	29.88	33.08	40.41	37.07	29.22	34.98	34.25	28.95	35.22	29.53
ANORTHITE	11.36	17.19	18.71	1.69	17.47	15.17	4.04	9.96	13.41	13.06	12.06
DIOPSIDE	----	----	----	----	----	----	----	----	----	----	----
HEDENBERGITE	----	----	----	----	----	----	----	----	----	----	----
ENSTATITE	3.02	2.78	4.87	4.15	4.25	3.67	2.50	2.85	4.08	3.81	3.45
FERROSILITE	1.83	2.47	2.70	3.62	3.23	2.07	1.73	2.43	1.81	2.25	0.56
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	1.82	2.60	1.89	0.64	1.03	2.62	1.64	1.53	2.60	1.74	3.16
ILMENITE	0.61	0.93	0.52	0.49	0.51	0.58	0.45	0.53	0.80	0.33	0.62
HEMATITE	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.33	0.31	0.26	0.26	0.24	0.31	0.26	0.26	0.29	0.14	0.26
PYRITE	----	----	----	0.06	----	----	0.02	----	0.04	----	----
CALCITE	0.02	0.28	0.19	1.41	0.31	0.83	0.35	0.35	0.63	0.94	0.81
TRACE ELEMENTS (PPM)											
ARSENIC	5	2	3	5	12	17	5	5	8	12	8
BARIUM	476	570	365	292	372	351	392	444	605	408	497
COPPER	2	100	4	388	47	4	20	5	43	2	10
FLUORINE	380	580	620	430	390	370	440	430	440	460	940
MOLYBDENUM	1.8	2.4	1.5	1.0	1.5	1.3	1.4	1.5	3.1	1.5	1.9
LEAD	2	7	3	3	3	5	10	12	14	8	16
RUBIDIUM	87	119	56	54	38	83	83	81	97	55	83
SULPHUR	40	30	50	300	20	20	100	60	220	40	40
TIN	1.8	2.8	1.2	1.4	1.5	1.6	1.8	2.2	2.6	2.7	3.7
STRONTIUM	323	350	235	148	253	288	305	296	325	235	310
ZINC	53	44	45	52	41	64	35	59	54	40	63
URANIUM	2.1	1.8	0.8	1.1	0.7	1.7	1.5	1.7	2.2	1.6	1.9

ST ANNS MOUNTAIN PLUTON LEUCOGRANITE

SAMPLE NO	K7A-1500	K7A-1507	K7A-1515	K7A-1546	K7A-1548	K7A-1555	K7A-1567	K7A-1570	K7A-1610	K7A-1625	K7A-1795	K7A-1796
SIO2	77.38	75.81	70.24	71.68	67.59	77.21	69.88	75.58	77.10	66.66	75.81	75.22
TIO2	0.15	0.15	0.30	0.37	0.42	0.10	0.33	0.20	0.16	0.16	0.17	0.23
AL2O3	11.03	11.27	14.62	11.68	13.54	10.30	14.97	11.90	11.07	14.92	11.36	11.72
FE2O3	0.62	0.13	1.01	0.99	1.35	0.82	1.33	0.85	0.44	0.88	0.76	1.22
FEO	0.70	0.95	1.81	2.28	1.87	0.07	1.60	0.84	0.87	1.49	0.90	0.83
MNO	0.02	0.02	0.07	0.06	0.07	0.00	0.08	0.02	0.01	0.05	0.03	0.03
MGO	0.10	0.14	1.05	1.14	1.16	0.11	1.07	0.28	0.22	1.63	0.35	0.45
CAO	1.12	0.98	1.76	2.07	2.90	0.70	2.00	1.19	0.36	2.52	1.23	1.13
NA2O	3.61	3.39	3.85	2.46	3.43	3.44	3.76	3.50	3.67	3.21	3.63	3.34
K2O	4.70	4.60	3.54	4.42	4.08	4.17	2.13	4.74	4.53	3.89	4.32	4.23
H2O+	0.64	0.78	1.43	1.86	1.47	2.45	1.35	0.55	0.59	1.09	0.89	0.53
H2O-	0.06	0.12	0.17	0.36	0.38	0.30	0.28	0.32	0.09	0.21	0.20	0.28
P2O5	0.05	0.04	0.10	0.10	0.13	0.04	0.11	0.05	0.05	0.06	0.03	0.04
CO2	0.32	0.15	0.18	0.84	1.09	0.38	0.33	0.31	0.16	0.26	0.39	0.26
TOTAL OXIDES	100.50	98.53	100.13	100.31	99.48	100.09	99.22	100.33	99.32	97.03	100.07	99.51
NORMATIVE MINERALOGY												
QUARTZ	37.49	37.36	29.26	36.37	27.28	42.04	35.38	35.26	37.98	26.48	36.60	37.75
CORUNDUM	----	----	1.95	1.32	1.07	----	3.93	----	----	1.65	----	0.25
ORTHOCLASE	27.81	27.82	21.26	26.62	24.73	25.30	12.85	28.21	27.18	24.05	25.78	25.31
ALBITE	30.54	29.39	32.99	21.15	29.73	29.84	32.61	29.80	31.50	28.30	30.97	28.65
ANORTHITE	0.05	1.99	7.06	4.41	6.81	0.42	7.43	2.74	0.32	11.02	2.03	3.88
DIOPSIDE	0.54	0.32	----	----	----	0.38	----	0.45	0.07	----	0.67	----
HEDENBERGITE	0.99	1.20	----	----	----	----	----	0.30	0.11	----	0.54	----
ENSTATITE	----	0.19	2.63	2.90	2.93	0.08	2.73	0.47	0.50	4.24	0.55	1.11
FERROSILITE	----	0.80	2.16	2.93	1.80	----	1.46	0.36	0.94	1.88	0.50	0.17
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.90	0.19	1.49	1.45	2.01	----	1.98	1.23	0.65	1.33	1.11	1.78
ILMENITE	0.29	0.29	0.58	0.70	0.80	0.13	0.64	0.38	0.31	0.32	0.31	0.44
HEMATITE	----	----	----	----	----	0.84	----	----	----	----	----	----
APATITE	0.12	0.10	0.24	0.21	0.31	0.07	0.24	0.09	0.09	0.12	0.05	0.07
PYRITE	----	----	----	----	----	----	0.02	----	----	0.02	----	----
CALCITE	0.73	0.35	0.39	1.95	2.54	0.87	0.75	0.71	0.35	0.59	0.90	0.58
TRACE ELEMENTS (PPM)												
ARSENIC	5	7	17	8	4	5	11	13	16	8	5	8
BARIUM	156	162	494	420	570	380	630	800	413	442	500	650
COPPER	4	4	6	12	8	4	8	2	1	15	10	15
FLUORINE	400	310	400	630	690	340	410	400	350	380	350	360
MOLYBDENUM	1.9	1.4	1.7	2.7	1.5	2.5	2.3	1.7	2.6	1.9	2.5	2.3
LEAD	16	9	138	10	9	5	12	13	12	14	20	14
RUBIDIUM	192	197	94	138	138	134	115	154	154	130	146	133
SULPHUR	60	40	60	10	20	40	170	30	30	100	80	40
TIN	7.7	7.7	1.8	2.5	3.2	4.3	2.2	4.6	5.0	2.8	5.0	5.1
STRONTIUM	17	31	325	78	242	40	228	62	59	202	38	81
ZINC	20	21	69	57	58	10	61	43	27	32	37	21
URANIUM	3.9	3.4	1.8	3.2	2.9	3.7	2.9	2.8	3.2	3.0	3.4	3.2

ST ANNS MOUNTAIN PLUTON LEUCOGRANITE

SAMPLE NO	K7A-1812
SIO2	71.35
TIO2	0.14
AL2O3	13.72
FE2O3	0.81
FEO	0.47
MNO	0.03
MGO	0.27
CAO	1.26
NA2O	3.73
K2O	4.61
H2O+	0.79
H2O-	0.18
P2O5	0.04
CO2	0.62
TOTAL OXIDES	98.02
NORMATIVE MINERALOGY	
QUARTZ	31.64
CORUNDUM	1.88
ORTHOCLASE	28.12
ALBITE	32.54
ANORTHITE	2.15
DIOPSIDE	----
HEDENBERGITE	----
ENSTATITE	0.67
FERROSILITE	0.03
FORSTERITE	----
FAYALITE	----
MAGNETITE	1.20
ILMENITE	0.26
HEMATITE	----
APATITE	0.07
PYRITE	----
CALCITE	1.45
TRACE ELEMENTS (PPM)	
ARSENIC	8
BARIUM	343
COPPER	11
FLUORINE	370
MOLYBDENUM	2.1
LEAD	20
RUBIDIUM	118
SULPHUR	20
TIN	1.9
STRONTIUM	170
ZINC	17
URANIUM	2.7

ST ANNS MOUNTAIN PLUTON QUARTZ DIORITE

SAMPLE NO	K7A-1501	K7A-1505	K7A-1525	K7A-1575	K7A-1601
SIO2	58.65	60.03	51.25	52.22	62.37
TIO2	1.24	0.94	1.05	0.84	0.72
AL2O3	16.60	16.49	16.77	17.80	16.03
FE2O3	3.09	3.17	3.54	3.87	2.93
FEO	4.34	3.66	4.54	4.52	2.79
MNO	0.16	0.14	0.16	0.14	0.16
MGO	3.62	3.37	6.28	3.43	2.50
CAO	4.93	4.58	7.44	5.71	3.81
NA2O	3.44	3.34	2.71	3.87	3.79
K2O	2.22	2.75	2.47	2.22	3.04
H2O+	2.05	1.91	1.59	3.01	1.72
H2O-	0.00	0.19	0.00	0.24	0.22
P2O5	0.23	0.20	0.18	0.26	0.10
CO2	0.38	0.05	0.15	2.39	0.21
TOTAL OXIDES	100.95	100.82	98.13	100.52	100.39
NORMATIVE MINERALOGY					
QUARTZ	14.45	14.82	1.82	9.59	17.05
CORUNDUM	1.02	0.27	----	4.92	0.25
ORTHOCLASE	13.22	16.48	15.08	13.45	18.27
ALBITE	29.35	28.63	23.68	33.68	32.58
ANORTHITE	20.85	21.44	27.30	11.91	17.32
DIOPSIDE	----	----	5.72	----	----
HEDENBERGITE	----	----	1.26	----	----
ENSTATITE	9.12	8.50	13.56	8.79	6.33
FERROSILITE	3.65	2.83	3.44	4.09	1.77
FORSTERITE	----	----	----	----	----
FAYALITE	----	----	----	----	----
MAGNETITE	4.53	4.66	5.34	5.77	4.32
ILMENITE	2.38	1.81	2.05	1.62	1.37
HEMATITE	----	----	----	----	----
APATITE	0.54	0.45	0.43	0.60	0.21
PYRITE	0.04	----	----	----	0.08
CALCITE	0.85	0.12	0.33	5.59	0.46
TRACE ELEMENTS (PPM)					
ARSENIC	7	6	6	10	6
BARIUM	509	590	480	280	700
COPPER	83	75	85	39	26
FLUORINE	520	750	620	640	620
MOLYBDENUM	2.5	2.7	2.0	2.3	1.2
LEAD	17	19	20	16	3
RUBIDIUM	87	97	85	86	78
SULPHUR	240	60	80	80	440
TIN	3.0	2.7	1.5	1.4	1.7
STRONTIUM	384	430	435	482	550
ZINC	95	97	160	143	85
URANIUM	2.0	2.0	1.2	0.7	1.3

ST ANNS MTN PLUTON PORPHYRITIC QUARTZ MONZONITE

SAMPLE NO	K7A-1520	K7A-1537	K7A-1627	K7A-1634
SIO2	72.48	64.56	65.27	64.72
TIO2	0.17	0.45	0.28	0.46
AL203	13.17	15.47	14.78	14.98
FE203	0.61	1.98	1.81	0.84
FEO	1.19	2.56	2.40	2.23
MNO	0.04	0.10	0.09	0.09
MGO	0.55	1.71	1.85	1.87
CAO	2.19	4.40	3.36	5.00
NA20	3.12	3.37	2.70	3.24
K20	3.78	2.84	3.90	2.62
H20+	0.62	1.56	1.50	1.68
H20-	0.00	0.23	0.20	0.11
P205	0.06	0.14	0.12	0.14
CO2	0.42	0.29	2.40	0.17
TOTAL OXIDES	98.40	99.66	100.66	98.15
NORMATIVE MINERALOGY				
QUARTZ	35.84	22.69	30.69	23.74
CORUNDUM	1.12	----	5.90	----
ORTHOCLASE	22.87	17.17	23.33	16.09
ALBITE	27.00	29.15	23.10	28.38
ANORTHITE	7.94	19.11	0.74	19.35
DIOPSIDE	----	0.25	----	2.39
HEDENBERGITE	----	0.13	----	1.26
ENSTATITE	1.40	4.24	4.66	3.70
FERROSILITE	1.41	2.52	2.64	2.23
FORSTERITE	----	----	----	----
FAYALITE	----	----	----	----
MAGNETITE	0.89	2.92	2.65	1.27
ILMENITE	0.31	0.85	0.52	0.91
HEMATITE	----	----	----	----
APATITE	0.14	0.31	0.26	0.31
PYRITE	0.11	----	----	----
CALCITE	0.98	0.67	5.52	0.38
TRACE ELEMENTS (PPM)				
ARSENIC	7	4	16	8
BARIUM	500	510	625	400
COPPER	6	29	31	13
FLUORINE	440	790	430	470
MOLYBDENUM	1.6	3.3	3.3	2.7
LEAD	46	18	20	14
RUBIDIUM	108	92	114	64
SULPHUR	500	30	40	40
TIN	1.0	2.1	2.3	1.9
STRONTIUM	232	358	400	402
ZINC	53	58	60	53
URANIUM	2.7	1.9	2.7	1.6

CAPE SMOKY PLUTON QUARTZ DIORITE,ETC

SAMPLE NO	K9B-1500	K9B-1524	K9B-1530	K9B-1556	K9B-1574	K9B-1575	K9B-1756
SIO2	59.37	55.33	48.17	59.70	52.22	54.65	61.90
TIO2	0.72	0.77	1.25	0.79	0.97	0.84	0.69
AL203	15.39	19.35	18.77	16.39	18.06	17.38	14.81
FE203	3.22	3.51	4.63	2.66	2.92	2.08	2.40
FEO	3.61	4.07	5.09	3.86	3.36	3.27	4.08
MNO	0.16	0.16	0.17	0.13	0.09	0.11	0.14
MGO	4.14	3.28	5.86	3.66	6.16	6.89	3.83
CAO	6.23	6.68	8.63	5.28	8.12	9.06	5.26
NA20	2.36	3.32	2.56	3.26	2.61	2.39	2.52
K20	2.98	1.32	1.97	1.94	1.72	1.11	2.74
H20+	1.73	1.67	2.69	1.66	3.01	1.90	0.79
H20-	0.14	0.00	0.00	0.00	0.00	0.00	0.01
P205	0.24	0.25	0.40	0.18	0.10	0.09	0.13
CO2	0.07	0.04	0.21	0.41	1.19	0.16	0.16
TOTAL OXIDES	100.36	99.75	100.40	99.92	100.53	99.93	99.46
NORMATIVE MINERALOGY							
QUARTZ	15.84	11.16	----	16.78	6.93	8.54	19.52
CORUNDUM	----	1.00	----	0.70	0.11	----	----
ORTHOCLASE	17.91	7.97	11.84	11.62	10.34	6.64	16.38
ALBITE	20.20	28.57	22.11	28.09	22.49	20.62	21.54
ANORTHITE	22.98	32.01	34.62	22.90	32.96	34.08	21.38
DIOPSIDE	4.06	----	3.35	----	----	7.09	1.87
HEDENBERGITE	1.06	----	0.64	----	----	1.03	0.79
ENSTATITE	8.57	8.33	13.01	9.26	15.66	14.19	8.78
FERROSILITE	2.56	3.65	2.83	3.84	1.53	2.37	4.26
FORSTERITE	----	----	0.23	----	----	----	----
FAYALITE	----	----	0.06	----	----	----	----
MAGNETITE	4.74	5.19	6.87	3.93	4.33	3.08	3.53
ILMENITE	1.37	1.47	2.42	1.51	1.86	1.61	1.33
HEMATITE	----	----	----	----	----	----	----
APATITE	0.54	0.57	0.95	0.40	0.21	0.19	0.28
PYRITE	----	0.02	0.59	0.04	0.82	0.23	----
CALCITE	0.16	0.07	0.49	0.95	2.74	0.35	0.35
TRACE ELEMENTS (PPM)							
ARSENIC	16	2	8	5	8	5	4
BARIUM	395	228	224	204	280	182	446
COPPER	5	21	78	28	75	79	15
FLUORINE	520	500	560	420	350	330	470
MOLYBDENUM	2.6	2.1	3.2	1.3	2.3	2.1	2.6
LEAD	11	2	2	2	4	2	2
RUBIDIUM	89	37	51	70	41	30	68
SULPHUR	10	120	2840	210	3900	1120	90
TIN	2.4	2.2	1.4	1.9	1.3	1.0	2.8
STRONTIUM	367	550	550	402	407	426	329
ZINC	77	76	86	67	47	46	73
URANIUM	0.7	1.0	0.4	1.9	0.6	0.5	1.7

CAPE SMOKY PLUTON GRANODIORITE,ETC

SAMPLE NO	K9B-1533	K9B-1537	K9B-1538	K9B-1578	K9B-1579
SIO2	65.61	63.92	71.56	65.55	72.27
TIO2	0.64	0.59	0.15	0.53	0.28
AL2O3	16.88	16.15	14.18	16.81	13.63
FE2O3	0.39	2.91	0.68	1.87	1.27
FEO	2.70	2.47	1.21	2.03	1.27
MNO	0.11	0.12	0.03	0.05	0.04
MGO	2.08	2.19	0.71	1.82	1.05
CAO	1.96	4.53	2.22	3.28	1.73
NA2O	3.17	3.52	3.19	4.57	4.05
K2O	3.53	2.16	4.50	2.11	2.52
H2O+	0.93	1.68	1.05	1.37	1.04
H2O-	0.00	0.00	0.00	0.00	0.00
P2O5	0.20	0.16	0.07	0.17	0.09
CO2	0.09	0.33	0.05	0.25	0.12
TOTAL OXIDES	98.29	100.73	99.60	100.41	99.36
NORMATIVE MINERALOGY					
QUARTZ	26.13	23.24	30.10	21.97	34.62
CORUNDUM	5.04	0.91	0.32	2.02	1.61
ORTHOCLASE	21.45	12.85	27.02	12.54	15.11
ALBITE	27.55	30.01	27.32	38.96	34.88
ANORTHITE	8.19	19.67	10.41	13.84	7.38
DIOPSIDE	----	----	----	----	----
HEDENBERGITE	----	----	----	----	----
ENSTATITE	5.30	5.49	1.80	4.58	2.64
FERROSILITE	3.81	1.36	1.50	1.31	0.89
FORSTERITE	----	----	----	----	----
FAYALITE	----	----	----	----	----
MAGNETITE	0.58	4.25	0.99	2.74	1.87
ILMENITE	1.25	1.11	0.29	1.02	0.52
HEMATITE	----	----	----	----	----
APATITE	0.45	0.35	0.14	0.38	0.19
PYRITE	0.06	0.02	----	0.10	0.02
CALCITE	0.19	0.74	0.12	0.55	0.28
TRACE ELEMENTS (PPM)					
ARSENIC	2	14	7	8	7
BARIUM	770	363	650	640	570
COPPER	21	22	7	24	1
FLUORINE	620	440	390	420	440
MOLYBDENUM	2.3	2.4	1.8	1.7	7.6
LEAD	2	4	2	2	2
RUBIDIUM	83	55	101	63	89
SULPHUR	320	100	40	510	150
TIN	1.4	3.2	1.1	1.4	1.5
STRONTIUM	465	446	250	343	210
ZINC	39	74	17	63	46
URANIUM	0.9	1.3	1.3	0.9	1.2

CAPE SMOKY PLUTON BIOTITE GRANITE

SAMPLE NO	K9B-1503	K9B-1509	K9B-1511	K9B-1512	K9B-1515	K9B-1529	K9B-1542	K9B-1543	K9B-1551	K9B-1555	K9B-1557	K9B-1559
SIO2	71.46	72.27	69.74	73.88	73.26	69.67	70.78	72.56	75.55	68.85	70.91	69.48
TIO2	0.20	0.18	0.20	0.16	0.17	0.33	0.25	0.13	0.15	0.45	0.30	0.45
AL203	14.37	14.92	15.04	13.68	14.11	15.51	15.65	14.69	13.36	15.59	14.40	14.15
FE203	1.69	0.96	1.52	0.39	0.81	1.18	1.16	0.83	0.82	1.63	1.00	1.34
FEO	1.25	1.21	1.33	0.75	0.99	1.45	1.95	1.15	0.83	2.04	1.53	2.00
MNO	0.04	0.03	0.05	0.02	0.02	0.05	0.06	0.03	0.02	0.07	0.04	0.07
MGO	0.68	0.73	1.10	0.71	0.64	0.87	1.00	0.69	0.57	0.85	0.78	1.69
CAO	2.73	2.96	2.89	1.83	2.45	2.89	2.94	2.70	1.93	3.19	2.57	2.85
NA20	3.15	5.28	2.83	3.96	3.26	4.15	4.47	2.52	3.26	3.94	3.41	3.90
K20	3.94	0.50	4.37	3.70	3.97	4.12	1.52	4.51	3.51	2.32	3.20	3.03
H20+	0.77	1.15	0.96	1.26	0.84	0.66	1.19	0.88	0.75	1.14	1.06	1.21
H20-	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P205	0.11	0.11	0.10	0.04	0.07	0.10	0.16	0.06	0.05	0.12	0.09	0.10
CO2	0.11	0.16	0.02	0.11	0.16	0.07	0.14	0.18	0.16	0.11	0.23	0.14
TOTAL OXIDES	100.59	100.46	100.15	100.49	100.75	101.05	101.27	100.93	100.96	100.30	99.52	100.41
NORMATIVE MINERALOGY												
QUARTZ	31.61	32.66	28.87	32.04	33.16	22.46	31.00	33.96	38.35	29.13	32.86	26.69
CORUNDUM	0.44	0.97	0.66	0.19	0.52	----	2.01	1.31	1.15	1.36	1.40	----
ORTHOCLASE	23.32	2.98	26.07	22.06	23.45	24.28	8.99	26.62	20.73	13.79	19.24	18.08
ALBITE	26.74	45.00	24.06	33.69	27.62	34.99	37.72	21.24	27.54	33.56	29.23	33.28
ANORTHITE	12.30	13.00	13.80	8.20	10.77	11.45	12.67	11.93	8.30	14.49	10.96	12.23
DIOPSIDE	----	----	----	----	----	0.99	----	----	----	----	----	0.33
HEDENBERGITE	----	----	----	----	----	0.48	----	----	----	----	----	0.13
ENSTATITE	1.67	1.83	2.76	1.78	1.60	1.70	2.49	1.72	1.42	2.14	1.97	4.07
FERROSILITE	0.63	1.22	0.92	0.84	0.91	0.96	2.30	1.27	0.63	1.78	1.59	1.84
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	2.46	1.39	2.22	0.56	1.18	1.71	1.68	1.20	1.17	2.39	1.47	1.96
ILMENITE	0.38	0.33	0.38	0.31	0.30	0.63	0.48	0.23	0.28	0.84	0.58	0.84
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.23	0.26	0.21	0.09	0.14	0.21	0.35	0.14	0.09	0.28	0.19	0.21
PYRITE	----	----	0.02	----	----	----	----	----	----	0.02	----	0.06
CALCITE	0.23	0.37	0.02	0.23	0.36	0.16	0.32	0.39	0.34	0.23	0.51	0.30
TRACE ELEMENTS (PPM)												
ARSENIC	2	7	4	3	3	3	4	4	4	5	6	4
BARIUM	750	88	640	480	550	910	230	878	530	520	1300	503
COPPER	3	2	7	3	4	8	3	5	4	22	27	15
FLUORINE	330	280	420	310	390	420	490	380	280	360	320	380
MOLYBDENUM	1.5	3.3	2.1	2.5	1.9	2.0	2.5	2.7	1.8	1.4	1.5	2.0
LEAD	6	1	4	2	2	2	2	4	6	4	6	6
RUBIDIUM	70	19	76	81	70	98	62	79	97	56	74	100
SULPHUR	20	20	160	10	10	10	60	30	10	170	80	310
TIN	1.4	1.6	2.0	1.8	0.8	1.7	1.9	0.6	1.6	1.6	1.1	1.4
STRONTIUM	343	450	383	141	268	418	308	341	134	261	225	253
ZINC	34	21	32	29	34	39	40	30	26	46	40	44
URANIUM	1.0	1.4	2.9	2.5	0.8	1.4	1.8	1.0	1.1	1.2	0.9	3.0

CAPE SMOKY PLUTON BIOTITE GRANITE

SAMPLE NO	K9B-1561	K9B-1563	K9B-1564	K9B-1565	K9B-1566	K9B-1568	K9B-1571	K9B-1572	K9B-1573	K9B-1576	K9B-1577	K9B-1580
SIO2	66.76	75.11	75.74	74.09	72.93	74.27	75.63	73.97	72.85	71.79	71.38	75.50
TIO2	0.42	0.15	0.11	0.17	0.18	0.18	0.14	0.13	0.15	0.23	0.27	0.12
AL2O3	16.96	12.96	12.88	13.83	13.43	14.11	13.02	12.19	12.99	14.41	15.11	12.05
FE2O3	1.34	0.35	0.44	0.49	0.70	0.28	0.61	0.41	0.32	0.94	0.74	0.41
FEO	1.70	0.63	0.57	0.73	1.03	1.07	0.50	0.40	0.57	1.40	1.07	0.57
MNO	0.05	0.01	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.04	0.03	0.01
MGO	1.36	0.35	0.37	0.55	0.70	0.64	0.29	0.16	0.37	1.17	0.83	0.36
CAO	3.30	1.46	0.96	1.62	1.78	1.31	1.43	1.14	1.32	1.88	2.31	0.94
NA2O	4.31	3.60	3.30	3.29	4.52	3.87	4.54	4.68	3.73	4.48	3.84	3.64
K2O	3.09	4.45	4.70	4.41	3.42	4.06	3.65	4.53	5.68	2.53	3.45	4.82
H2O+	0.11	0.66	0.75	0.99	0.86	0.81	0.54	0.49	1.04	1.34	0.93	0.77
H2O-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P2O5	0.12	0.03	0.03	0.04	0.06	0.06	0.03	0.02	0.03	0.10	0.08	0.03
CO2	0.05	0.12	0.09	0.12	0.09	0.02	0.14	0.17	0.11	0.34	0.09	0.09
TOTAL OXIDES	99.57	99.88	99.95	100.35	99.73	100.70	100.53	98.30	99.17	100.65	100.13	99.31
NORMATIVE MINERALOGY												
QUARTZ	20.74	34.04	36.38	34.19	29.28	32.00	32.56	29.39	27.46	31.06	29.88	34.30
CORUNDUM	0.95	----	0.87	1.10	----	1.13	----	----	----	1.92	1.22	----
ORTHOCLASE	18.38	26.49	27.99	26.21	20.47	24.05	21.61	27.41	34.26	15.08	20.58	28.89
ALBITE	36.67	30.64	28.09	28.03	38.70	32.79	38.35	38.27	32.18	38.10	32.76	31.27
ANORTHITE	15.31	6.15	4.16	7.02	6.32	6.05	4.38	----	1.95	6.64	10.59	2.36
DIOPSIDE	----	0.13	----	----	0.89	----	1.04	0.88	1.97	----	----	0.94
HEDENBERGITE	----	0.08	----	----	0.50	----	0.28	1.03	1.08	----	----	0.47
ENSTATITE	3.38	0.79	0.91	1.38	1.33	1.60	0.22	----	----	2.94	2.06	0.45
FERROSILITE	1.42	0.56	0.55	0.70	0.85	1.49	0.07	----	----	1.48	0.99	0.26
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	1.95	0.51	0.63	0.70	1.01	0.41	0.89	----	0.46	1.37	1.08	0.59
ILMENITE	0.78	0.29	0.19	0.31	0.33	0.32	0.25	0.23	0.29	0.44	0.50	0.23
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.28	0.05	0.05	0.09	0.14	0.14	0.05	0.05	0.05	0.21	0.16	0.05
PYRITE	0.02	----	----	----	----	----	----	----	----	----	----	0.02
CALCITE	0.11	0.28	0.18	0.28	0.18	0.02	0.32	0.37	0.23	0.78	0.18	0.19
TRACE ELEMENTS (PPM)												
ARSENIC	3	7	11	7	4	5	2	3	8	14	8	11
BARIUM	690	1110	530	610	478	490	288	220	660	450	675	705
COPPER	9	0	0	0	0	2	0	0	0	0	0	4
FLUORINE	420	320	280	310	380	300	280	330	290	600	560	340
MOLYBDENUM	1.9	1.7	1.1	1.8	2.5	1.2	1.3	1.8	1.8	1.5	1.5	2.1
LEAD	12	8	10	8	6	8	12	14	14	2	6	8
RUBIDIUM	87	118	147	147	95	139	158	139	123	69	92	136
SULPHUR	130	10	10	10	30	20	10	10	10	50	10	100
TIN	1.2	0.9	0.9	1.6	1.3	1.2	1.5	1.1	0.8	1.4	1.4	1.2
STRONTIUM	278	113	92	113	165	120	59	475	641	218	185	70
ZINC	47	20	28	26	32	26	13	14	47	38	31	22
URANIUM	1.6	1.6	2.0	2.3	2.7	2.5	1.4	1.2	2.0	1.8	2.0	1.4

CAPE SMOKY PLUTON BIOTITE GRANITE

SAMPLE NO	K9B-1581	K9B-1584	K9B-1585	K9B-1586	K9B-1750	K9B-1754	K9B-1760	K9B-1763	K9B-1764	K9B-1769
SIO2	73.90	74.12	72.21	73.21	72.49	72.91	75.11	73.62	75.33	73.96
TIO2	0.13	0.22	0.22	0.18	0.17	0.18	0.20	0.17	0.15	0.22
AL203	13.29	13.15	14.68	13.91	14.19	12.70	13.08	13.61	13.48	12.79
FE203	0.67	0.77	1.20	0.57	0.63	0.77	0.53	0.46	0.37	1.74
FEO	0.97	0.72	1.03	1.07	1.01	0.83	0.92	1.27	0.90	1.13
MNO	0.04	0.03	0.07	0.03	0.02	0.03	0.02	0.03	0.02	0.03
MGO	0.61	0.21	0.98	0.61	0.52	0.73	0.50	0.65	0.47	0.76
CAO	1.66	1.71	2.22	2.20	1.33	1.88	1.22	1.41	1.60	1.28
NA20	3.37	3.28	3.38	3.34	3.73	4.11	3.56	3.84	3.84	3.73
K20	4.67	4.90	4.03	3.69	3.81	3.91	4.11	4.23	4.02	3.08
H20+	0.93	1.00	0.94	0.87	1.36	0.79	1.08	1.03	0.61	1.10
H20-	0.00	0.00	0.06	0.04	0.12	0.00	0.09	0.00	0.00	0.00
P205	0.05	0.04	0.08	0.06	0.04	0.05	0.04	0.06	0.04	0.04
CO2	0.07	0.07	0.09	0.04	0.21	0.14	0.18	0.18	0.11	0.14
TOTAL OXIDES	100.36	100.22	101.19	99.82	99.63	99.03	100.64	100.56	100.94	100.00
NORMATIVE MINERALOGY										
QUARTZ	32.06	32.94	31.07	34.14	33.39	30.45	35.67	31.17	33.24	37.36
CORUNDUM	----	----	1.13	0.65	2.09	----	1.06	0.72	0.23	1.41
ORTHOCLASE	27.74	29.23	23.81	22.02	22.98	23.50	24.45	25.10	23.71	18.37
ALBITE	28.70	27.99	28.48	28.58	32.19	35.42	30.30	32.67	32.40	31.92
ANORTHITE	7.41	6.70	9.92	10.45	5.19	4.74	4.69	5.51	7.02	5.33
DIOPSIDE	0.06	0.60	----	----	----	2.20	----	----	----	----
HEDENBERGITE	0.04	0.39	----	----	----	0.69	----	----	----	----
ENSTATITE	1.48	0.23	2.44	1.51	1.30	0.83	1.25	1.60	1.17	1.91
FERROSILITE	1.05	0.17	0.67	1.28	1.10	0.30	0.95	1.73	1.10	0.35
FORSTERITE	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.98	1.13	1.72	0.84	0.92	1.12	0.76	0.67	0.54	2.55
ILMENITE	0.23	0.40	0.40	0.33	0.31	0.33	0.38	0.31	0.28	0.40
HEMATITE	----	----	----	----	----	----	----	----	----	----
APATITE	0.09	0.09	0.19	0.14	0.07	0.10	0.09	0.14	0.09	0.09
PYRITE	----	----	----	----	----	----	----	----	----	----
CALCITE	0.16	0.14	0.18	0.07	0.46	0.32	0.39	0.39	0.23	0.30
TRACE ELEMENTS (PPM)										
ARSENIC	11	1	4	4	4	8	7	1	13	3
BARIUM	218	368	400	496	1200	605	1330	630	460	1015
COPPER	6	1	2	8	2	6	1	3	3	1
FLUORINE	340	280	340	500	380	370	350	520	340	360
MOLYBDENUM	2.2	1.9	1.8	2.6	2.3	2.1	2.1	2.5	1.9	2.4
LEAD	10	16	6	10	4	6	4	6	6	2
RUBIDIUM	173	177	134	133	82	123	103	109	115	67
SULPHUR	60	10	10	90	20	40	10	70	10	30
TIN	1.3	1.2	1.4	1.5	1.5	1.7	1.5	1.1	1.1	2.5
STRONTIUM	181	158	245	211	113	118	77	128	82	170
ZINC	29	24	50	34	31	27	27	30	29	32
URANIUM	2.2	2.9	2.7	1.5	1.3	2.0	2.0	1.9	1.6	1.4

WHITE POINT PLUTON GRANODIORITE

SAMPLE NO	K16-1009	K16-1016	K16-1026	K16-1045	K16-1094	K16-1111
SIO2	63.14	69.03	68.76	67.75	70.96	65.16
TIO2	0.74	0.08	0.32	0.32	0.35	0.50
AL203	18.35	16.03	15.87	15.77	14.97	18.23
FE203	0.55	0.33	0.67	0.56	1.02	0.69
FEO	2.50	0.47	1.83	1.87	1.25	2.23
MNO	0.26	0.01	0.03	0.04	0.02	0.03
MGO	1.57	0.25	0.42	0.94	0.64	1.55
CAO	4.51	2.57	2.15	2.46	2.04	3.94
NA20	4.75	5.58	4.40	4.69	3.77	4.68
K20	2.68	2.82	3.11	3.09	4.15	2.33
H20+	1.07	0.57	0.84	0.78	0.83	0.98
H20-	0.16	0.18	0.22	0.09	0.05	0.15
P205	0.22	0.06	0.17	0.16	0.12	0.20
CO2	0.17	0.15	0.21	0.15	0.09	0.28
TOTAL OXIDES	100.67	98.13	99.00	98.67	100.26	100.95
NORMATIVE MINERALOGY						
QUARTZ	12.82	21.07	26.61	22.26	28.18	18.42
CORUNDUM	0.33	----	2.29	1.01	1.06	1.98
ORTHOCLASE	15.95	17.08	18.73	18.70	24.71	13.75
ALBITE	40.43	48.51	38.03	40.50	32.02	39.69
ANORTHITE	20.06	10.65	8.47	10.39	8.89	16.52
DIOPSIDE	----	0.53	----	----	----	----
HEDENBERGITE	----	0.36	----	----	----	----
ENSTATITE	3.93	0.39	1.04	2.40	1.60	3.84
FERROSILITE	3.42	0.31	2.36	2.56	0.94	2.76
FORSTERITE	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----
MAGNETITE	0.80	0.48	0.98	0.83	1.49	1.00
ILMENITE	1.40	0.16	0.62	0.62	0.65	0.95
HEMATITE	----	----	----	----	----	----
APATITE	0.49	0.12	0.40	0.38	0.28	0.47
PYRITE	----	----	----	----	----	----
CALCITE	0.37	0.35	0.47	0.35	0.18	0.62
TRACE ELEMENTS (PPM)						
ARSENIC	14	3	5	2	5	7
BARIUM	860	1010	1030	595	720	720
COPPER	15	1	1	17	8	8
FLUORINE	840	420	520	670	460	540
MOLYBDENUM	1.2	1.4	1.0	2.3	1.2	1.4
LEAD	22	26	35	24	32	19
RUBIDIUM	95	91	172	114	150	140
SULPHUR	60	20	30	60	20	80
TIN	2.1	1.4	6.6	4.5	2.8	2.2
STRONTIUM	790	990	403	812	435	677
ZINC	65	23	79	58	43	59
URANIUM	3.8	0.7	2.1	1.1	1.6	1.1

WHITE POINT PLUTON GRANITE

SAMPLE NO	K16-1002	K16-1023	K16-1029	K16-1032	K16-1038	K16-1040	K16-1043	K16-1049	K16-1051	K16-1053	K16-1055	K16-1061
SIO2	75.89	74.20	73.00	71.90	72.50	73.21	71.65	72.81	72.65	74.31	72.64	70.16
TIO2	0.06	0.04	0.13	0.11	0.18	0.15	0.17	0.15	0.17	0.10	0.09	0.11
AL203	11.39	13.86	13.15	14.28	14.30	13.77	15.38	13.87	14.31	13.68	14.18	15.81
FE203	0.21	0.12	0.23	0.28	0.10	0.58	0.30	0.29	0.39	0.35	0.07	0.41
FEO	0.47	0.70	1.13	0.70	1.36	1.03	0.87	1.12	1.11	0.80	0.85	0.65
MNO	0.01	0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01
MGO	0.11	0.06	0.28	0.20	0.40	0.34	0.44	0.28	0.37	0.21	0.26	0.25
CAO	1.59	1.08	0.88	1.59	1.29	1.70	2.23	1.69	1.11	1.49	2.31	2.36
NA20	4.14	4.38	4.10	4.06	3.95	3.75	4.68	3.19	4.20	3.81	5.33	5.39
K20	4.27	4.30	4.36	4.52	4.43	4.37	3.65	4.96	4.87	4.78	2.86	2.41
H20+	0.45	0.34	0.74	0.68	0.63	0.50	0.58	0.70	0.75	0.55	0.58	0.85
H20-	0.19	0.19	0.20	0.13	0.11	0.09	0.09	0.07	0.05	0.07	0.05	0.03
P205	0.07	0.03	0.11	0.07	0.07	0.07	0.08	0.09	0.07	0.06	0.06	0.06
C02	0.24	0.14	0.12	0.12	0.17	0.15	0.12	0.10	0.12	0.21	0.10	0.05
TOTAL OXIDES	99.09	99.45	98.45	98.65	99.51	99.73	100.25	99.33	100.19	100.43	99.39	98.55
NORMATIVE MINERALOGY												
QUARTZ	34.37	30.16	30.87	28.01	29.28	30.84	25.17	31.56	26.77	30.65	26.41	24.81
CORUNDUM	----	0.42	0.64	0.26	1.25	0.26	0.11	0.64	0.59	0.13	----	0.33
ORTHOCLASE	25.67	25.73	26.47	27.34	26.54	26.09	21.69	29.79	29.00	28.34	17.08	14.55
ALBITE	35.31	37.40	35.51	35.12	33.85	32.02	39.78	27.32	35.69	32.31	45.69	46.64
ANORTHITE	----	4.41	2.98	6.82	4.88	7.16	9.89	7.29	4.27	5.75	6.43	11.29
DIOPSIDE	0.55	----	----	----	----	----	----	----	----	----	1.21	----
HEDENBERGITE	1.24	----	----	----	----	----	----	----	----	----	2.37	----
ENSTATITE	----	0.15	0.69	0.51	1.01	0.83	1.08	0.68	0.90	0.50	0.07	0.64
FERROSILITE	----	1.13	1.75	0.89	2.16	1.20	1.11	1.60	1.47	1.04	0.16	0.72
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	0.20	0.18	0.34	0.42	0.15	0.83	0.44	0.41	0.56	0.51	0.09	0.59
ILMENITE	0.12	0.08	0.23	0.19	0.33	0.29	0.31	0.29	0.31	0.19	0.15	0.20
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.17	0.05	0.26	0.17	0.16	0.14	0.16	0.19	0.16	0.14	0.12	0.12
PYRITE	----	----	----	----	----	----	----	----	----	----	----	----
CALCITE	0.53	0.30	0.26	0.28	0.39	0.34	0.27	0.23	0.28	0.46	0.23	0.12
TRACE ELEMENTS (PPM)												
ARSENIC	5	5	3	2	5	8	4	12	5	12	5	8
BARIUM	22	35	750	275	580	560	940	600	545	408	680	980
COPPER	1	1	2	47	3	1	7	1	0	0	1	1
FLUORINE	430	390	320	440	440	390	420	580	420	500	490	470
MOLYBDENUM	1.9	1.8	1.0	2.2	2.6	1.0	0.8	4.0	2.7	2.7	1.3	1.6
LEAD	33	37	41	214	29	37	58	38	29	43	29	35
RUBIDIUM	284	297	165	188	204	186	114	229	178	194	86	108
SULPHUR	20	20	10	10	30	30	10	10	30	50	10	10
TIN	4.6	2.8	2.6	3.3	3.3	3.0	1.8	3.8	2.8	3.6	5.2	3.4
STRONTIUM	41	50	302	196	282	245	520	168	270	121	601	1350
ZINC	22	21	42	79	37	43	40	53	52	33	44	29
URANIUM	3.9	2.1	2.8	2.9	4.8	2.1	0.8	5.0	11.6	4.1	1.0	0.7

WHITE POINT PLUTON GRANITE

SAMPLE NO	K16-1064	K16-1070	K16-1072	K16-1073	K16-1077	K16-1085	K16-1086	K16-1089	K16-1097	K16-1098	K16-1100	K16-1104
SIO2	74.06	72.45	72.75	72.80	73.08	71.12	73.39	73.86	73.56	74.21	75.55	72.96
TIO2	0.08	0.16	0.17	0.17	0.09	0.33	0.10	0.16	0.18	0.11	0.05	0.12
AL203	13.42	15.25	13.93	13.41	15.37	15.08	13.96	14.31	14.31	14.00	13.85	14.46
FE203	0.83	0.28	0.95	0.25	0.30	0.48	0.54	0.69	0.40	0.03	0.14	0.46
FEO	0.47	0.99	0.81	0.87	0.59	1.00	0.73	1.00	1.09	1.13	0.47	0.83
MNO	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01
MGO	0.20	0.32	0.35	0.33	0.17	0.49	0.25	0.25	0.20	0.19	0.10	0.16
CAO	1.57	2.07	1.04	1.69	1.62	1.95	1.65	1.61	1.48	1.55	0.71	1.30
NA20	3.58	4.17	3.56	3.52	3.51	4.66	3.82	3.81	3.14	3.81	4.04	3.87
K20	4.91	3.98	4.06	4.86	2.31	4.57	4.32	4.42	5.54	4.53	4.91	5.37
H20+	0.44	0.56	0.63	0.66	0.69	0.66	0.54	0.50	0.62	0.73	0.40	0.49
H20-	0.04	0.02	0.05	0.04	0.03	0.02	0.08	0.09	0.06	0.08	0.04	0.04
P205	0.04	0.07	0.07	0.06	0.04	0.15	0.07	0.05	0.12	0.11	0.02	0.12
CO2	0.14	0.12	0.15	0.21	0.21	0.14	0.12	0.17	0.14	0.07	0.16	0.17
TOTAL OXIDES	99.79	100.46	98.54	98.88	98.02	100.67	99.59	100.94	100.85	100.56	100.45	100.36
NORMATIVE MINERALOGY												
QUARTZ	31.66	28.05	34.92	30.48	41.60	22.29	31.33	31.01	30.64	30.78	31.83	27.28
CORUNDUM	----	0.77	2.35	----	4.86	----	0.48	0.84	1.05	0.41	1.02	0.58
ORTHOCLASE	29.20	23.58	24.56	29.29	14.05	26.99	25.78	26.01	32.67	26.87	28.99	31.83
ALBITE	30.43	35.26	30.80	30.26	30.54	39.37	32.59	32.14	26.54	32.33	34.11	32.82
ANORTHITE	6.16	9.09	3.85	6.59	6.65	6.77	7.00	6.58	5.75	6.63	2.44	4.62
DIOPSIDE	0.43	----	----	0.08	----	0.54	----	----	----	----	----	----
HEDENBERGITE	0.04	----	----	0.10	----	0.36	----	----	----	----	----	----
ENSTATITE	0.30	0.80	0.87	0.80	0.41	0.97	0.63	0.62	0.50	0.48	0.25	0.40
FERROSILITE	0.03	1.33	0.45	1.12	0.72	0.74	0.78	1.04	1.41	1.91	0.69	0.96
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	1.20	0.41	1.41	0.37	0.45	0.70	0.78	0.98	0.58	0.04	0.19	0.65
ILMENITE	0.15	0.30	0.31	0.31	0.16	0.63	0.19	0.30	0.32	0.19	0.10	0.23
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.09	0.14	0.14	0.14	0.10	0.35	0.16	0.09	0.26	0.23	0.05	0.26
PYRITE	----	----	----	----	----	----	----	----	----	----	----	----
CALCITE	0.30	0.27	0.35	0.46	0.47	0.30	0.28	0.39	0.30	0.14	0.34	0.39
TRACE ELEMENTS (PPM)												
ARSENIC	8	5	3	12	5	8	1	8	5	5	7	8
BARIUM	92	415	342	330	172	430	330	620	690	278	62	415
COPPER	2	0	2	1	0	0	1	3	0	0	0	0
FLUORINE	430	470	400	370	330	440	390	470	380	390	150	240
MOLYBDENUM	1.9	2.9	1.3	2.5	2.6	1.0	2.6	2.6	2.5	1.4	1.2	2.3
LEAD	43	33	21	24	33	39	37	39	43	37	43	36
RUBIDIUM	243	199	273	271	115	189	224	326	238	235	264	241
SULPHUR	10	10	10	40	10	40	60	40	70	30	40	40
TIN	2.2	2.8	3.6	3.8	4.2	5.1	5.1	3.9	5.5	6.3	1.7	4.5
STRONTIUM	128	278	142	154	183	270	248	242	148	164	106	190
ZINC	25	33	41	41	36	46	44	64	42	49	14	33
URANIUM	2.9	1.8	2.4	3.2	1.7	1.7	1.6	2.2	3.2	3.4	3.2	1.7

WHITE POINT PLUTON GRANITE

SAMPLE NO	K16-1106	K16-1107	K16-1120	K16-1123	K16-1127	K16-1129	K16-1131	K16-1133
SIO2	73.10	74.24	74.32	72.63	72.97	73.22	72.72	74.40
TIO2	0.13	0.12	0.14	0.18	0.13	0.11	0.10	0.10
AL203	13.71	14.36	13.93	14.72	14.78	13.91	14.14	13.78
FE203	0.44	0.69	0.41	0.44	0.29	0.44	0.23	0.52
FEO	1.01	0.85	0.76	1.23	0.79	0.90	0.83	0.63
MNO	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
MGO	0.17	0.18	0.22	0.48	0.18	0.22	0.20	0.34
CAO	1.51	1.30	1.52	1.64	1.66	1.73	1.71	1.84
NA20	3.46	3.63	3.65	4.07	4.36	3.36	4.22	2.60
K20	4.89	4.88	5.04	4.03	4.14	5.27	4.36	4.55
H20+	0.36	0.52	0.55	0.69	0.65	0.65	0.74	0.64
H20-	0.07	0.10	0.00	0.03	0.01	0.03	0.00	0.00
P205	0.07	0.07	0.08	0.09	0.09	0.14	0.08	0.05
C02	0.23	0.12	0.14	0.29	0.17	0.16	0.17	0.29
TOTAL OXIDES	99.16	101.07	100.77	100.53	100.23	100.15	99.52	99.76
NORMATIVE MINERALOGY								
QUARTZ	31.49	31.50	30.36	29.70	28.36	29.98	28.08	38.48
CORUNDUM	0.67	1.20	0.18	1.56	0.71	0.22	----	2.02
ORTHOCLASE	29.27	28.70	29.71	23.89	24.55	31.36	26.13	27.17
ALBITE	29.60	30.51	30.83	34.43	37.08	28.52	36.09	22.12
ANORTHITE	5.74	5.23	6.25	5.79	6.62	6.78	6.86	7.10
DIOPSIDE	----	----	----	----	----	----	0.05	----
HEDENBERGITE	----	----	----	----	----	----	0.10	----
ENSTATITE	0.40	0.42	0.52	1.20	0.43	0.53	0.48	0.83
FERROSILITE	1.32	0.82	0.87	1.62	1.02	1.13	1.14	0.57
FORSTERITE	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----
MAGNETITE	0.63	0.98	0.58	0.64	0.42	0.64	0.32	0.76
ILMENITE	0.23	0.23	0.25	0.32	0.23	0.19	0.19	0.19
HEMATITE	----	----	----	----	----	----	----	----
APATITE	0.14	0.14	0.16	0.19	0.19	0.30	0.17	0.09
PYRITE	----	----	----	----	----	----	----	----
CALCITE	0.51	0.27	0.30	0.66	0.39	0.34	0.39	0.67
TRACE ELEMENTS (PPM)								
ARSENIC	3	8	7	8	4	8	5	16
BARIUM	660	630	310	1010	630	440	432	152
COPPER	1	0	1	1	1	6	2	7
FLUORINE	420	360	580	540	490	560	500	420
MOLYBDENUM	2.3	2.1	2.3	1.1	1.5	2.2	1.6	410.0
LEAD	46	36	102	32	37	47	37	24
RUBIDIUM	269	217	202	155	268	259	204	295
SULPHUR	40	20	90	40	40	10	70	30
TIN	3.8	3.7	27.0	2.3	1.7	5.8	4.2	4.6
STRONTIUM	184	168	140	329	222	150	123	105
ZINC	44	56	40	44	39	51	40	28
URANIUM	3.6	3.4	7.0	1.2	2.8	8.2	5.8	6.0

WHITE POINT PLUTON GRANITE (APLITE)

SAMPLE NO	K16-1035	K16-1080
SIO2	73.60	74.45
TIO2	0.04	0.04
AL203	14.72	14.22
FE203	0.15	0.17
FEO	0.48	0.50
MNO	0.05	0.05
MGO	0.02	0.13
CAO	1.46	0.83
NA20	4.37	4.38
K20	4.44	3.32
H20+	0.45	0.44
H20-	0.11	0.01
P205	0.04	0.04
C02	0.14	0.09
TOTAL OXIDES	100.07	98.67
NORMATIVE MINERALOGY		
QUARTZ	28.31	35.03
CORUNDUM	0.48	2.28
ORTHOCLASE	26.35	19.95
ALBITE	37.17	37.67
ANORTHITE	6.19	3.36
DIOPSIDE	----	----
HEDENBERGITE	----	----
ENSTATITE	0.05	0.30
FERROSILITE	0.78	0.80
FORSTERITE	----	----
FAYALITE	----	----
MAGNETITE	0.20	0.25
ILMENITE	0.08	0.08
HEMATITE	----	----
APATITE	0.09	0.10
PYRITE	----	----
CALCITE	0.30	0.19
TRACE ELEMENTS (PPM)		
ARSENIC	7	4
BARIUM	18	7
COPPER	1	0
FLUORINE	400	400
MOLYBDENUM	2.0	1.7
LEAD	32	24
RUBIDIUM	387	475
SULPHUR	30	10
TIN	3.8	5.2
STRONTIUM	75	58
ZINC	21	21
URANIUM	3.6	2.4

GILLIS MOUNTAIN PLUTON QUARTZ MONZODIORITE

SAMPLE NO	F16C-1029	F16C-1030	F16C-1046	F16C-1066	F16C-1105	F16C-1110	F16C-1113	F16C-1129	F16C-1136
SIO2	61.17	62.26	58.94	61.40	60.35	59.10	60.68	59.25	58.10
TIO2	1.47	1.29	1.54	1.29	1.39	1.34	1.24	1.49	1.50
AL203	17.04	15.91	17.44	16.47	16.55	16.72	15.35	15.38	15.75
FE203	1.27	0.68	1.13	1.19	1.62	0.86	1.50	1.79	1.64
FEO	6.02	5.25	6.62	5.41	5.50	5.84	5.31	5.98	6.47
MNO	0.10	0.10	0.13	0.05	0.11	0.12	0.10	0.15	0.15
MGO	2.50	2.23	2.70	2.27	2.52	2.43	2.50	3.01	3.26
CAO	4.91	4.38	4.92	4.72	5.25	4.48	4.60	4.61	5.45
NA20	3.46	3.60	3.62	3.70	3.61	3.43	3.58	3.87	3.86
K20	1.10	2.87	2.13	2.49	2.40	2.26	2.52	2.45	2.30
H20+	0.95	0.90	0.76	1.31	1.18	1.78	1.93	1.24	0.96
H20-	0.41	0.43	0.00	0.00	0.00	0.00	0.05	0.00	0.11
P205	0.32	0.31	0.38	0.34	0.39	0.35	0.33	0.43	0.36
CO2	0.12	0.11	0.05	0.18	0.07	0.52	0.11	0.25	0.12
TOTAL OXIDES	100.84	100.32	100.36	100.82	100.94	99.23	99.80	99.90	100.03
NORMATIVE MINERALOGY									
QUARTZ	20.98	16.27	12.47	15.33	13.77	16.46	15.76	11.99	9.27
CORUNDUM	2.30	----	1.29	0.32	----	2.59	----	----	----
ORTHOCLASE	6.50	17.06	12.59	14.74	14.24	13.72	15.15	14.69	13.68
ALBITE	29.16	30.53	30.74	31.45	30.55	29.79	30.83	33.19	32.89
ANORTHITE	21.44	18.91	21.64	20.23	21.94	17.10	18.82	17.56	19.11
DIOPSIDE	----	0.09	----	----	0.53	----	0.69	0.58	2.22
HEDENBERGITE	----	0.08	----	----	0.49	----	0.60	0.49	1.91
ENSTATITE	6.22	5.54	6.75	5.66	6.02	6.21	6.03	7.33	7.17
FERROSILITE	6.36	5.90	8.82	6.74	6.39	8.17	6.03	7.03	7.06
FORSTERITE	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----
MAGNETITE	1.84	0.99	1.66	1.73	2.36	1.28	2.22	2.65	2.40
ILMENITE	2.77	2.44	2.92	2.44	2.65	2.61	2.40	2.87	2.88
HEMATITE	----	----	----	----	----	----	----	----	----
APATITE	0.74	0.72	0.89	0.77	0.91	0.81	0.78	0.99	0.84
PYRITE	1.42	1.24	0.12	0.21	0.02	0.04	0.44	0.08	0.31
CALCITE	0.27	0.23	0.11	0.39	0.14	1.21	0.23	0.55	0.28
TRACE ELEMENTS (PPM)									
ARSENIC	5	8	7	7	12	7	12	7	3
BARIUM	794	938	740	940	805	710	760	710	780
COPPER	330	28	57	68	30	136	83	150	630
FLUORINE	700	600	670	500	500	800	580	670	660
MOLYBDENUM	4.0	4.0	3.2	3.2	2.9	3.3	3.7	6.1	3.5
LEAD	16	16	5	12	16	33	21	21	23
RUBIDIUM	73	118	125	80	84	122	103	113	90
SULPHUR	6900	6000	700	1000	100	200	2120	420	1520
TIN	2.7	2.7	1.8	2.2	1.6	2.8	1.4	1.9	1.5
STRONTIUM	540	459	480	460	483	414	442	445	465
ZINC	93	93	58	53	120	88	90	73	90
URANIUM	2.0	3.1	1.8	2.3	1.8	2.1	2.5	2.4	1.9

GILLIS MOUNTAIN PLUTON PORPHYRITIC GRANITE

SAMPLE NO	F16C-1023	F16C-1033	F16C-1035	F16C-1037	F16C-1039	F16C-1044	F16C-1049	F16C-1050	F16C-1051	F16C-1053	F16C-1055	F16C-1057
SIO2	65.49	68.54	66.76	67.65	68.20	68.47	68.90	67.58	65.85	67.55	67.45	66.15
TIO2	0.77	0.65	0.72	0.69	0.57	0.80	0.52	0.59	0.56	0.62	0.57	0.58
AL203	15.75	14.97	15.31	15.41	14.94	15.18	12.93	15.90	14.91	15.30	15.48	15.38
FE203	1.35	0.30	0.87	0.38	1.30	1.55	0.61	0.96	1.11	0.60	1.03	1.17
FEO	3.30	3.08	2.84	3.26	2.56	2.16	2.57	2.79	2.85	2.92	2.94	2.63
MNO	0.04	0.04	0.04	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
MGO	1.73	1.30	1.07	1.51	1.47	1.25	1.18	1.37	1.44	1.30	1.46	1.50
CAO	2.74	2.79	3.00	2.80	2.91	2.85	2.87	3.13	2.83	2.76	3.14	2.69
NA20	3.77	3.79	3.54	4.14	3.67	3.81	3.52	3.83	3.74	3.61	3.73	3.78
K20	2.90	3.58	3.64	3.01	3.77	3.45	3.64	3.25	3.54	2.36	3.70	3.60
H20+	1.80	0.91	1.10	1.46	1.00	1.06	0.85	0.83	1.05	1.17	0.94	1.24
H20-	0.28	0.36	0.41	0.00	0.20	0.00	0.22	0.27	0.08	0.25	0.07	0.05
P205	0.20	0.14	0.20	0.16	0.06	0.13	0.14	0.15	0.06	0.16	0.15	0.15
C02	0.14	0.07	0.13	0.11	0.02	0.19	0.15	0.09	0.14	0.16	0.02	0.02
TOTAL OXIDES	100.26	100.52	99.63	100.63	100.73	100.95	98.15	100.79	98.21	98.81	100.73	98.99
NORMATIVE MINERALOGY												
QUARTZ	24.07	23.63	24.01	22.74	23.27	25.37	27.47	23.36	22.06	29.68	21.60	22.20
CORUNDUM	2.28	0.25	0.86	0.91	----	0.74	----	0.96	0.26	2.64	----	0.77
ORTHOCLASE	17.41	21.29	21.95	17.95	22.36	20.44	22.19	19.30	21.57	14.28	21.93	21.71
ALBITE	32.29	32.33	30.53	35.23	31.22	32.28	30.61	32.44	32.51	31.28	31.62	32.69
ANORTHITE	11.58	12.71	13.06	12.26	13.22	12.12	9.04	14.04	13.16	11.95	14.59	12.59
DIOPSIDE	----	----	----	----	0.39	----	1.59	----	----	----	0.02	----
HEDENBERGITE	----	----	----	----	0.26	----	1.62	----	----	----	0.01	----
ENSTATITE	4.35	3.24	2.72	3.77	3.48	3.12	2.27	3.40	3.67	3.30	3.63	3.82
FERROSILITE	2.88	4.42	3.44	4.56	2.67	1.44	2.65	3.44	3.42	3.98	3.37	2.56
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	1.99	0.44	1.29	0.56	1.88	2.25	0.91	1.40	1.66	0.89	1.50	1.73
ILMENITE	1.47	.23	1.37	1.32	1.09	1.52	1.00	1.11	1.08	1.21	1.09	1.11
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.47	0.30	0.47	0.37	0.14	0.28	0.31	0.35	0.12	0.38	0.33	0.33
PYRITE	0.92	0.02	0.02	0.10	----	----	0.02	0.02	0.17	0.04	0.31	0.48
CALCITE	0.30	0.14	0.28	0.23	0.02	0.43	0.33	0.18	0.33	0.37	0.02	0.02
TRACE ELEMENTS (PPM)												
ARSENIC	12	8	7	5	8	3	8	3	8	7	5	3
BARIUM	1015	765	840	903	1060	815	748	895	732	840	750	850
COPPER	89	48	89	295	33	16	24	55	35	73	42	175
FLUORINE	600	400	140	500	620	550	500	370	650	550	540	580
MOLYBDENUM	3.8	3.6	3.9	6.4	2.6	5.4	3.2	3.1	2.0	3.8	3.4	5.1
LEAD	423	12	38	18	11	8	8	18	48	28	16	72
RUBIDIUM	190	192	195	163	175	147	129	136	155	162	140	185
SULPHUR	4500	100	100	500	60	10	100	100	860	200	1500	2380
TIN	4.6	1.8	1.8	3.2	1.5	1.5	1.5	2.5	1.7	2.7	1.2	2.4
STRONTIUM	395	311	326	329	350	273	274	307	300	280	342	288
ZINC	90	36	80	100	30	35	47	47	62	56	41	140
URANIUM	2.6	3.9	3.9	3.5	2.8	3.6	4.4	3.6	3.8	4.1	3.8	3.1

GILLIS MOUNTAIN PLUTON PORPHYRITIC GRANITE

SAMPLE NO	F16C-1059	F16C-1064	F16C-1072	F16C-1074	F16C-1075	F16C-1076	F16C-1081	F16C-1086	F16C-1094	F16C-1102	F16C-1104	F16C-1111
SIO2	65.09	67.31	66.69	66.00	67.60	68.96	66.07	66.73	67.68	68.13	68.30	67.92
TIO2	0.56	0.58	0.71	0.58	0.61	0.48	0.62	0.64	0.54	0.65	0.55	0.63
AL2O3	15.52	14.50	13.40	15.25	15.09	14.98	15.42	14.88	15.70	15.45	15.20	15.52
FE2O3	0.83	0.69	0.86	0.96	2.19	1.24	1.61	0.73	1.22	1.21	1.67	0.43
FEO	2.86	3.06	3.90	2.80	1.93	1.76	2.03	2.05	1.97	2.48	2.08	2.48
MNO	0.05	0.05	0.04	0.05	0.07	0.02	0.05	0.05	0.03	0.05	0.05	0.02
MGO	1.26	1.43	1.78	1.46	1.50	1.26	1.14	1.09	1.48	1.31	1.37	1.28
CAO	3.45	2.68	2.27	2.28	2.34	0.50	2.28	3.44	2.27	2.90	2.87	2.67
NA2O	3.80	3.59	3.15	3.69	3.91	3.64	3.64	3.68	3.56	3.55	3.89	3.79
K2O	3.38	4.68	3.26	3.52	3.57	4.14	3.60	3.96	3.87	3.77	3.62	3.46
H2O+	0.92	0.93	1.31	1.29	0.96	2.31	1.55	1.12	1.04	0.87	0.95	1.45
H2O-	0.00	0.00	0.00	0.05	0.08	0.22	0.23	0.09	0.20	0.00	0.10	0.00
P2O5	0.14	0.15	0.15	0.16	0.17	0.15	0.17	0.15	0.16	0.16	0.16	0.14
CO2	0.09	0.14	0.14	0.05	0.18	0.14	0.12	0.10	0.18	0.09	0.19	0.07
TOTAL OXIDES	97.95	99.79	97.66	98.14	100.20	99.80	98.53	98.71	99.90	100.62	101.00	99.86
NORMATIVE MINERALOGY												
QUARTZ	20.92	20.32	27.98	24.00	24.93	29.99	25.54	22.17	25.63	24.54	23.88	24.75
CORUNDUM	----	----	1.30	1.78	1.37	4.39	2.15	----	2.34	0.84	0.45	1.15
ORTHOCLASE	20.45	27.95	19.96	21.42	21.22	25.12	21.95	23.97	23.21	22.31	21.43	20.68
ALBITE	32.89	30.67	27.59	32.12	33.25	31.67	31.83	31.94	30.54	30.04	32.94	32.50
ANORTHITE	15.74	9.71	9.67	10.33	9.50	0.70	9.76	12.70	9.22	12.87	12.06	12.18
DIOPSIDE	0.20	0.79	----	----	----	----	----	1.52	----	----	----	----
HEDENBERGITE	0.14	0.73	----	----	----	----	----	1.02	----	----	----	----
ENSTATITE	3.10	3.20	4.59	3.75	3.77	3.20	2.93	2.08	3.71	3.27	3.39	3.23
FERROSILITE	2.53	3.38	4.90	3.15	0.50	1.45	1.50	1.61	1.65	2.58	1.57	2.55
FORSTERITE	----	----	----	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----	----	----	----
MAGNETITE	1.23	1.01	1.29	1.44	3.19	1.85	2.41	1.09	1.79	1.76	2.42	0.63
ILMENITE	1.07	1.09	1.40	1.12	1.15	0.94	1.22	1.25	1.02	1.22	1.05	1.19
HEMATITE	----	----	----	----	----	----	----	----	----	----	----	----
APATITE	0.31	0.35	0.36	0.36	0.40	0.33	0.41	0.36	0.38	0.37	0.35	0.31
PYRITE	1.22	0.48	0.64	0.42	0.35	0.02	0.02	0.06	0.13	0.02	0.04	0.69
CALCITE	0.19	0.32	0.33	0.12	0.39	0.33	0.28	0.23	0.39	0.18	0.43	0.14
TRACE ELEMENTS (PPM)												
ARSENIC	11	11	7	7	7	7	4	11	8	2	4	11
BARIUM	840	850	1010	750	920	1150	900	895	810	875	720	800
COPPER	43	38	158	65	61	64	74	293	3000	29	41	275
FLUORINE	580	470	560	470	480	390	430	500	600	300	540	500
MOLYBDENUM	3.3	2.0	5.2	2.9	3.3	4.5	3.4	8.8	2.2	3.1	3.5	6.7
LEAD	18	438	950	90	23	17	34	121	80	16	25	100
RUBIDIUM	184	167	173	156	160	241	152	237	223	159	154	164
SULPHUR	5900	2380	3040	2000	1800	120	120	300	640	100	260	3300
TIN	1.5	1.6	1.2	1.7	1.8	3.0	1.6	2.3	7.1	2.0	1.7	3.5
STRONTIUM	308	340	220	282	350	225	319	285	300	283	242	335
ZINC	94	287	620	430	54	142	98	61	780	38	40	560
URANIUM	3.6	4.7	3.5	3.6	3.2	3.7	4.0	4.7	3.7	3.5	3.4	4.4

GILLIS MOUNTAIN PLUTON	PORPHYRITIC GRANITE			
SAMPLE NO	F16C-1115	F16C-1117	F16C-1120	F16C-1134
SIO2	68.57	66.66	68.98	68.03
TIO2	0.64	0.61	0.69	0.61
AL203	15.21	14.81	14.87	14.60
FE203	0.90	1.19	0.93	1.69
FEO	2.85	3.16	2.51	2.59
MNO	0.03	0.05	0.05	0.06
MGO	1.36	1.61	1.36	1.50
CAO	2.47	2.93	2.85	2.80
NA20	3.74	3.69	3.37	3.65
K20	3.10	3.29	3.62	3.49
H20+	1.43	1.49	0.86	1.43
H20-	0.41	0.15	0.26	0.03
P205	0.16	0.18	0.14	0.18
CO2	0.09	0.09	0.00	0.18
TOTAL OXIDES	100.96	99.91	100.49	100.85
NORMATIVE MINERALOGY				
QUARTZ	27.26	23.41	26.74	25.28
CORUNDUM	1.83	0.47	0.56	0.58
ORTHOCLASE	18.42	19.79	21.54	20.72
ALBITE	31.80	31.67	28.69	31.09
ANORTHITE	10.73	13.14	13.32	11.67
DIOPSIDE	----	----	----	----
HEDENBERGITE	----	----	----	----
ENSTATITE	3.39	4.05	3.38	3.76
FERROSILITE	3.04	3.72	2.67	2.48
FORSTERITE	----	----	----	----
FAYALITE	----	----	----	----
MAGNETITE	1.32	1.76	1.36	2.47
ILMENITE	1.23	1.16	1.32	1.15
HEMATITE	----	----	----	----
APATITE	0.37	0.40	0.30	0.42
PYRITE	0.44	0.25	0.12	----
CALCITE	0.18	0.19	----	0.39
TRACE ELEMENTS (PPM)				
ARSENIC	3	4	12	8
BARIUM	1042	920	1040	950
COPPER	165	294	60	13
FLUORINE	500	800	500	560
MOLYBDENUM	2.7	4.2	4.4	6.3
LEAD	18	18	100	21
RUBIDIUM	162	175	135	162
SULPHUR	2200	1240	700	40
TIN	1.4	1.7	2.6	1.0
STRONTIUM	299	315	279	312
ZINC	68	70	122	44
URANIUM	3.6	3.2	4.4	3.1

GILLIS MOUNTAIN PLUTON	FINE-GRAINED GRANITE						
SAMPLE NO	F16C-1017	F16C-1024	F16C-1043	F16C-1119	F16C-1124	F16C-1127	F16C-1137
SIO2	67.91	68.39	68.55	69.09	65.79	70.43	67.70
TIO2	0.67	0.57	0.60	0.59	0.75	0.53	0.65
AL203	14.69	14.59	15.17	14.52	15.21	14.64	15.01
FE203	0.67	0.85	1.33	0.64	0.66	0.74	0.53
FEO	3.28	2.90	2.30	2.80	3.09	2.64	2.95
MNO	0.05	0.06	0.04	0.03	0.05	0.02	0.05
MGO	1.02	1.24	1.30	1.16	1.18	0.87	1.18
CAO	2.26	2.09	2.02	2.21	2.48	1.68	2.51
NA20	3.54	3.75	3.65	3.48	3.32	3.71	3.64
K20	4.05	3.98	3.91	4.02	4.09	4.20	3.81
H20+	0.95	1.15	1.21	1.24	0.88	0.79	0.90
H20-	0.26	0.37	0.18	0.33	0.36	0.07	0.39
P205	0.17	0.10	0.08	0.15	0.14	0.15	0.14
CO2	0.07	0.32	0.02	0.15	0.11	0.16	0.03
TOTAL OXIDES	99.59	100.36	100.36	100.41	98.11	100.63	99.49
NORMATIVE MINERALOGY							
QUARTZ	24.60	24.83	26.02	26.70	23.48	27.33	23.98
CORUNDUM	0.90	1.27	1.51	1.13	1.40	1.66	0.69
ORTHOCLASE	24.30	23.78	23.22	24.00	24.95	24.85	22.92
ALBITE	30.38	32.05	31.08	29.71	28.89	31.39	31.32
ANORTHITE	9.93	7.84	9.45	9.13	11.16	6.44	11.67
DIOPSIDE	----	----	----	----	----	----	----
HEDENBERGITE	----	----	----	----	----	----	----
ENSTATITE	2.58	3.12	3.23	2.89	3.01	2.17	2.96
FERROSILITE	4.00	3.42	1.21	3.04	3.79	3.36	3.67
FORSTERITE	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----
MAGNETITE	0.99	1.25	1.94	0.94	0.99	1.06	0.78
ILMENITE	1.29	1.09	1.15	1.11	1.47	1.01	1.24
HEMATITE	----	----	----	----	----	----	----
APATITE	0.38	0.21	0.19	0.35	0.31	0.33	0.31
PYRITE	0.52	0.42	0.99	0.69	0.32	0.06	0.42
CALCITE	0.14	0.74	0.02	0.32	0.24	0.34	0.05
TRACE ELEMENTS (PPM)							
ARSENIC	5	8	8	2	4	3	7
BARIUM	832	880	1020	960	1083	930	860
COPPER	35	26	68	48	48	344	23
FLUORINE	580	650	650	600	500	730	600
MOLYBDENUM	4.2	3.4	6.6	4.0	3.5	5.6	4.9
LEAD	25	18	446	41	128	18	43
RUBIDIUM	190	137	155	153	154	155	169
SULPHUR	2500	2000	4800	3300	1500	300	2000
TIN	3.5	3.5	3.6	4.4	2.9	0.3	1.9
STRONTIUM	260	288	217	239	248	221	233
ZINC	127	131	71	450	134	61	102
URANIUM	3.2	3.8	3.7	3.6	3.1	3.8	3.4

GILLIS MOUNTAIN PLUTON MINOR PHASES

SAMPLE NO	F16C-1026	F16C-1060	F16C-1061	F16C-1079	F16C-1083	F16C-1091	F16C-1116	F16C-1088
SIO2	70.75	70.27	68.96	75.54	64.51	69.47	69.16	76.78
TIO2	0.40	0.28	0.38	0.00	0.74	0.59	0.42	0.02
AL203	14.35	13.10	14.03	13.06	15.13	14.97	14.65	12.05
FE203	0.78	0.25	0.95	0.58	2.06	1.49	0.92	0.58
FEO	2.63	1.97	0.85	0.25	2.70	1.92	2.63	0.33
MNO	0.03	0.06	0.02	0.01	0.09	0.02	0.03	0.00
MGO	0.69	1.07	0.35	0.07	1.56	1.16	0.65	0.05
CAO	1.30	1.97	3.91	0.04	2.69	1.13	1.08	0.54
NA2O	3.62	3.37	3.54	3.89	4.22	3.36	3.57	3.75
K2O	3.86	4.19	3.18	4.36	2.34	3.84	3.54	4.46
H2O+	1.52	1.93	1.66	1.03	1.57	2.38	1.55	1.11
H2O-	0.19	1.31	0.00	0.05	0.39	0.03	0.16	0.09
P2O5	0.10	0.11	0.11	0.02	0.32	0.16	0.13	0.02
CO2	0.32	1.01	2.43	0.16	0.05	0.09	0.09	0.12
TOTAL OXIDES	100.54	100.89	100.37	99.06	98.37	100.61	98.58	99.90
NORMATIVE MINERALOGY								
QUARTZ	31.07	31.37	34.57	37.05	23.90	31.77	31.76	37.50
CORUNDUM	2.87	2.07	3.57	1.98	1.73	3.89	3.61	0.42
ORTHOCLASE	23.04	25.29	18.99	26.32	14.36	23.14	21.61	26.73
ALBITE	30.99	29.17	30.24	33.59	36.97	28.88	31.08	32.15
ANORTHITE	3.83	2.81	3.36	----	11.30	4.13	4.08	1.76
DIOPSIDE	----	----	----	-.37	----	----	----	----
HEDENBERGITE	----	----	----	----	----	----	----	----
ENSTATITE	1.74	2.73	0.86	----	4.03	2.92	1.65	0.13
FERROSILITE	3.48	2.69	----	----	2.28	1.39	3.29	0.10
FORSTERITE	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----
MAGNETITE	1.14	0.37	0.19	0.82	3.10	2.19	1.38	0.85
ILMENITE	0.77	0.53	0.73	----	1.44	1.12	0.80	0.04
HEMATITE	----	----	0.82	0.03	----	----	----	----
APATITE	0.21	0.24	0.23	0.05	0.77	0.38	0.31	0.05
PYRITE	0.13	0.42	0.87	----	----	0.02	0.26	----
CALCITE	0.74	2.33	5.58	0.35	0.12	0.19	0.19	0.28
TRACE ELEMENTS (PPM)								
ARSENIC	8	7	11	8	8	8	7	8
BARIUM	920	1035	775	162	670	955	920	161
COPPER	21	68	44	53	297	49	34	42
FLUORINE	440	300	500	350	580	400	380	200
MOLYBDENUM	2.8	3.6	3.9	2.5	1.8	4.0	4.0	3.8
LEAD	54	536	18	68	30	12	59	95
RUBIDIUM	127	246	187	294	153	191	136	358
SULPHUR	700	2100	4300	60	80	100	1240	40
TIN	2.4	1.7	2.6	2.2	5.4	3.2	2.1	2.4
STRONTIUM	197	179	183	73	331	198	208	63
ZINC	84	2200	81	41	47	76	220	35
URANIUM	4.0	5.4	4.3	9.5	3.6	4.5	4.5	10.8

DEEP COVE PLUTON GRANITE

SAMPLE NO	F116-1202	F116-1203	F116-1209	F116-1214	F116-1216	F116-1217	F116-1220	F116-1222	F116-1225
SIO2	72.05	69.80	72.05	67.00	70.56	73.28	73.42	73.20	74.15
TIO2	0.39	0.43	0.33	0.84	0.43	0.39	0.26	0.40	0.23
AL203	13.17	14.22	13.13	15.88	14.45	13.35	13.73	13.75	13.70
FE203	0.22	0.11	0.44	0.64	0.17	0.49	0.36	0.36	0.39
FEO	1.33	2.93	1.41	2.85	2.96	2.07	0.97	1.50	0.43
MNO	0.02	0.06	0.04	0.06	0.04	0.04	0.02	0.02	0.03
MGO	0.86	1.16	0.82	1.92	1.07	0.82	0.72	0.86	0.26
CAO	1.22	1.93	1.32	3.34	2.66	1.47	1.59	1.49	0.66
NA20	3.16	3.96	3.21	4.24	3.96	3.32	3.36	3.26	2.63
K20	4.45	3.99	4.49	1.54	2.23	4.24	4.22	4.36	4.08
H20+	0.75	0.84	0.68	1.54	0.54	0.68	0.83	0.94	1.35
H20-	0.02	0.04	0.03	0.02	0.00	0.00	0.01	0.02	0.06
P205	0.18	0.15	0.12	0.24	0.12	0.11	0.11	0.13	0.09
CO2	0.07	0.07	0.05	0.05	0.08	0.07	0.05	0.07	0.15
TOTAL OXIDES	97.89	99.69	98.12	100.16	99.27	100.33	99.65	100.36	98.21
NORMATIVE MINERALOGY									
QUARTZ	33.76	24.92	33.07	26.13	31.08	32.90	33.73	32.95	43.49
CORUNDUM	1.57	0.42	1.02	1.86	1.17	1.06	1.16	1.39	4.44
ORTHOCLASE	27.06	23.71	27.14	9.17	13.27	25.13	25.22	25.95	24.94
ALBITE	27.46	33.66	27.67	36.37	33.63	28.06	28.70	27.76	22.91
ANORTHITE	4.65	8.22	5.57	14.95	12.00	6.16	6.94	6.27	1.86
DIOPSIDE	----	----	----	----	----	----	----	----	----
HEDENBERGITE	----	----	----	----	----	----	----	----	----
ENSTATITE	2.18	2.89	2.09	4.85	2.68	2.05	1.79	2.13	0.64
FERROSILITE	1.66	3.52	0.68	3.27	3.09	2.36	1.06	1.83	0.13
FORSTERITE	----	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----	----
MAGNETITE	0.33	0.16	0.65	0.94	0.25	0.71	0.53	0.53	0.58
ILMENITE	0.76	0.80	0.64	1.60	0.80	0.74	0.48	0.77	0.45
HEMATITE	----	----	----	----	----	----	----	----	----
APATITE	0.41	0.35	0.28	0.54	0.26	0.26	0.26	0.28	0.19
PYRITE	0.02	1.20	1.07	0.21	1.59	0.43	0.02	0.02	----
CALCITE	0.14	0.14	0.12	0.12	0.18	0.14	0.12	0.14	0.35
TRACE ELEMENTS (PPM)									
ARSENIC	7	3	8	7	7	16	5	7	11
BARIUM	915	750	710	850	870	780	670	900	740
COPPER	32	184	251	25	50	44	17	12	43
FLUORINE	520	520	870	760	600	440	500	490	440
MOLYBDENUM	7.4	7.0	7.2	6.9	6.2	5.3	2.5	10.0	4.7
LEAD	33	33	41	54	150	72	22	33	15
RUBIDIUM	213	199	197	137	54	190	188	190	235
SULPHUR	100	5900	5150	1000	7750	2150	140	190	70
TIN	2.0	4.7	4.4	7.7	1.2	2.8	2.9	2.1	3.2
STRONTIUM	193	235	214	342	308	188	244	220	85
ZINC	49	260	341	107	600	314	51	44	308
URANIUM	6.2	4.8	5.8	3.7	5.4	7.0	5.7	5.6	5.7

PETIT-DE-GRAT PLUTON LEUCOGRANITE

SAMPLE NO	F7.2-1000	F7.2-1001	F7.2-1003	F7.2-1004	F7.2-1009	F7.2-1012	F7.2-1013	F7.2-1014
SIO2	76.53	75.46	78.12	77.21	79.10	77.45	80.43	78.43
TIO2	0.11	0.12	0.10	0.10	0.09	0.10	0.09	0.11
AL2O3	11.58	11.72	11.92	10.84	11.19	11.43	10.46	11.77
FE2O3	0.36	0.41	0.27	0.25	0.33	0.20	0.33	0.28
FEO	0.32	0.29	0.39	0.46	0.35	0.59	0.36	0.38
MNO	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
MGO	0.15	0.11	0.08	0.11	0.07	0.08	0.05	0.05
CAO	0.78	0.71	0.71	0.81	0.69	0.61	0.64	0.64
NA2O	3.98	4.60	4.21	3.79	2.56	3.48	2.73	3.76
K2O	3.97	4.73	4.14	3.69	4.73	5.27	4.61	4.63
H2O+	0.45	0.45	0.46	0.50	0.43	0.74	0.37	0.36
H2O-	0.41	0.26	0.33	0.33	0.38	0.35	0.40	0.34
P2O5	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
CO2	0.16	0.02	0.00	0.11	0.07	0.11	0.07	0.10
TOTAL OXIDES	98.83	98.91	100.75	98.22	100.01	100.44	100.56	100.87
NORMATIVE MINERALOGY								
QUARTZ	37.67	32.60	36.50	40.72	45.00	36.31	45.64	37.70
CORUNDUM	----	----	----	----	0.75	----	----	----
ORTHOCLASE	23.92	28.45	24.45	22.37	28.17	31.39	27.34	27.30
ALBITE	34.39	34.63	35.65	32.95	21.85	29.63	23.16	31.78
ANORTHITE	2.04	----	1.42	1.71	3.07	----	2.64	1.55
DIOPSIDE	0.54	0.55	0.43	0.55	----	0.43	0.05	0.26
HEDENBERGITE	0.16	0.61	0.63	0.89	----	1.36	0.09	0.59
ENSTATITE	0.13	----	----	----	0.15	----	0.10	0.01
FERROSILITE	0.04	----	----	----	0.24	----	0.21	0.02
FORSTERITE	----	----	----	----	----	----	----	----
FAYALITE	----	----	----	----	----	----	----	----
MAGNETITE	0.53	----	0.38	0.36	0.48	0.28	0.48	0.39
ILMENITE	0.19	0.23	0.19	0.20	0.15	0.19	0.15	0.19
HEMATITE	----	----	----	----	----	----	----	----
APATITE	0.02	0.02	0.02	----	----	----	----	----
PYRITE	----	----	----	0.02	----	0.04	----	----
CALCITE	0.35	0.02	----	0.23	0.14	0.23	0.14	0.23
TRACE ELEMENTS (PPM)								
ARSENIC	7	5	2	4	13	8	17	12
BARIUM	378	384	395	379	313	393	253	247
COPPER	0	1	15	0	2	9	1	1
FLUORINE	40	90	50	30	40	40	50	30
MOLYBDENUM	1.8	4.6	2.3	2.5	2.7	3.3	3.1	2.1
LEAD	8	8	8	11	11	14	12	12
RUBIDIUM	170	225	123	158	338	275	320	335
SULPHUR	40	0	20	100	0	240	40	20
TIN	5.5	4.8	4.6	5.0	5.0	5.7	6.1	5.2
STRONTIUM	47	53	44	55	40	41	53	35
ZINC	9	12	9	15	12	19	10	25
URANIUM	9.5	5.4	6.2	10.8	12.9	12.4	7.4	8.8

Table E-1. Huntington Mountain pluton.

Sample Nos.	Dioritic Complex		Porphyritic Quartz Monzonite		Biotite granite and leucogranite					Aplite
	1555	1634	1561	1613	1631	1578	1605	1618	1529	1579
SiO_2	47.19	58.88	70.64	72.79	70.36	71.36	72.07	75.44	76.13	73.44
Sb	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
B	16	4	7	5	3	6	4	3	6	4
Be	3.4	4.5	3.3	3.2	3.4	3.4	4.5	4.3	9.5	3.0
Bi	0.11	0.05	0.18	0.05	0.13	0.10	0.08	0.09	0.20	0.17
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	34	15	4	5	3	3	1	2	1	1
Li	12	17	7	7	2	7	6	6	7	4
Ni	3	16	3	6	3	2	1	1	1	18
Nb	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Y	60	71	27	40	39	40	30	19	24	36
Zr	217	415	265	275	265	204	359	180	220	346

Table E-2. Kellys Mountain pluton.

	Dioritic Complex						Biotite Granodiorite		
Sample Nos.	1093	1125	1130	1095	1109	1031	1090	1208	1206
SiO_2	47.95	50.42	51.68	53.22	54.53	63.90	67.26	67.45	69.97
Sb	<3	<3	<3	<3	<3	<3	<3	<3	<3
B	10	110	73	9	15	15	10	10	12
Be	2.5	1.9	2.7	3.0	2.0	2.8	4.4	2.8	3.7
Bi	0.05	0.05	0.04	0.19	0.06	0.07	0.05	0.10	0.09
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	54	27	27	21	22	5	3	3	1
Li	14	31	25	20	32	34	42	39	45
Ni	3	67	15	1	102	4	5	1	1
Nb	<100	<100	<100	<100	<100	<100	<100	<100	<100
Y	38	15	29	46	31	21	52	34	28
Zr	238	60	255	273	165	275	450	290	278

	Leucogranite									Fine grained granite	
Sample Nos.	1027	1148	1185	1108	1084	1120	1178	1067	1076	1171	1149
SiO_2	68.89	70.52	71.33	72.95	73.77	75.20	76.62	76.76	76.99	75.58	77.25
Sb	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
B	16	7	9	6	13	6	9	5	6	6	9
Be	2	4	4.5	3.9	5.4	3.0	4.6	3.6	2.9	7.1	5.2
Bi	0.05	0.02	0.05	0.05	0.04	0.76	0.06	0.05	0.05	0.06	0.06
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	1	2	1	0	2	1	1	0	0	1	1
Li	38	17	27	12	33	41	24	10	8	18	20
Ni	4	3	1	2	3	4	1	1	3	5	4
Nb	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Y	30	22	25	27	35	14	45	9	17	33	19
Zr	365	410	160	393	180	133	265	140	145	190	63

Table E-3. St. Anns Mountain pluton.

	Hornblende	Granodorite, etc			Grano-diorite	Hornblende biotite granite
Sample Nos.	1574	1534	1634	1784	1605	1514
SiO_2	52.95	60.92	64.72	65.98	63.92	70.11
Sb	<3	<3	<3	<3	<3	<3
B	15	16	5	10	18	6
Be	3.1	2.2	2.0	3.2	3	3.2
Bi	0.10	0.11	0.13	0.10	0.10	0.03
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	27	15	12	9	8	7
Li	12	15	16	12	20	25
Ni	12	10	5	5	18	1
Nb	<100	<100	<100	<100	<100	<100
y	39	29	22	29	21	27
Zr	77	150	215	235	180	248

	Leucogranite		Aplite	Quartz diorite		Late Aplite
Sample Nos.	1548	1570	1504	1525	1575	1509
SiO_2	67.59	75.58	77.48	51.25	52.22	72.51
Sb	<3	<3	<3	<3	<3	<3
B	9	3	6	10	13	3
Be	3.2	4.9	5.1	2.5	3.3	4.3
Bi	0.08	0.08	0.04	0.06	0.07	0.02
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	7	1	1	26	22	1
Li	10	7	8	18	26	7
Ni	3	5	2	26	9	1
Nb	<100	<100	<100	<100	<100	<100
y	24	59	56	23	37	81
Zr	243	285	213	140	65	285

Table E-4. Cape Smoky pluton.

	Quartz diorite		Grano-diorite	Quartz monzo-diorite	Biotite granite				Aplite
Sample Nos.	1575	1500	1578	1533	1584	1568	1551	1571	1535
SiO_2	54.65	59.37	65.55	76.45	74.12	74.27	75.55	75.63	76.45
Sb	<3	<3	<3	<3	<3	<3	<3	<3	<3
B	11	10	11	11	6	6	6	4	6
Be	2.0	1.6	2.4	2.1	3.4	4.3	2.9	4.1	2.4
Bi	0.13	0.14	0.10	0.14	0.09	0.08	0.08	0.09	0.09
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	26	18	7	9	1	1	1	1	1
Li	18	8	32	25	12	33	26	14	8
Ni	61	25	7	2	1	1	1	1	1
Nb	<100	<100	<100	<100	<100	<100	<100	<100	<100
Y	5	17	9	43	11	8	8	13	6
Zr	140	68	220	440	185	145	110	155	140

Table E-5. White Point pluton.

Sample Nos.	Foliated Grano-diorite	Granodiorite			Granite		
	1009	1111	1026	1016	1061	1032	1104
SiO_2	63.14	65.15	68.76	69.03	70.16	71.90	72.96
Sb	<3	<3	<3	<3	<3	<3	<3
B	7	5	5	3	4	5	4
Be	3.6	4.3	6.2	7.7	6.2	4.6	6.0
Bi	0.14	0.08	0.08	0.08	0.15	0.09	0.07
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	9	10	5	2	3	4	2
Li	109	89	85	51	65	52	61
Ni	7	12	3	3	6	6	2
Nb	<100	<100	<100	<100	<100	<100	<100
Y	12	6	75	9	3	11	6
Zr	160	262	215	195	160	130	140

Sample Nos.	Granite						Aplite
	1106	1097	1023	1098	1100	1002	1035
SiO_2	73.10	73.56	74.20	74.21	75.55	75.89	73.60
Sb	<3	<3	<3	<3	<3	<3	<3
B	3	6	5	6	3	6	8
Be	4.3	5.5	9.1	7.3	8.8	7.5	17.0
Bi	0.09	0.24	0.04	0.24	0.15	0.09	0.6
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	3	1	3	2	2	1	3
Li	59	81	43	99	43	89	29
Ni	3	4	3	2	2	3	6
Nb	<100	<100	<100	<100	<100	<100	<100
Y	10	11	8	13	7	12	7
Zr	180	185	150	115	157	160	155

Table E-6. Gillis Mountain and Deep Cove plutons.

	Quartz monzodiorite		Porphyritic granite					Fine grained granite		Deep Cove pluton granite
Sample Nos.	1136	1105	1023	1055	1075	1033	1120	1024	1119	1222
SiO_2	58.10	60.35	65.49	67.45	67.60	68.54	68.98	68.39	69.09	73.20
Sb	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
B	5	7	7	4	6	8	7	7	7	10
Be	3.1	2.2	3.1	3.6	2.8	2.9	2.2	3.9	3.3	2.5
Bi	0.04	0.06	0.90	0.07	0.05	0.04	0.07	0.09	0.08	1.70
Cd	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co	23	21	2	8	4	4	7	8	9	1
Li	22	10	30	31	36	37	23	25	37	19
Ni	27	25	7	10	10	12	8	9	13	4
Nb	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Y	39	36	34	41	30	21	19	63	45	18
Zr	160	160	204	192	208	258	255	280	277	103